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MONTHLY WEATHER REVIEW

VOLUME 46, No. 8

AUGUST, 1918

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NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the MONTHLY WEATHER REVIEW (e. g., January) should be in the hands of the editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

REPRINTS are made up without covers in the original size and pagination of the REVIEW. They will not be furnished unless specifically REQUESTED WHEN THE MANUSCRIPT IS SUBMITTED.

MONTHLY WEATHER REVIEW

HERBERT H. KIMBALL, Acting Editor.

VOL. 46, No. 8.
W. B. No. 661.

AUGUST, 1918.

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INTRODUCTION.

As explained in this Introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS to the MONTHLY WEATHER REVIEW are published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Since August, 1915, the material for the MONTHLY WEATHER REVIEW has been prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoertical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meterological Summary and chart No. 9 of the Nôrth Atlantic Ocean for this month in 1917. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general, appropriate officials prepare the seven sections above enumerated; *but* all *students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.*

The voluminous tables of data and text relative to local climatological conditions, that during recent years were prepared by the 12 respective "district editors," are omitted from the MONTHLY WEATHER REVIEW, but are collected and published by States at selected section centers. (See cover, p. 3.)

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are specially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belen College, Habana.
The Government Meteorological Office of Jamaica.
The Meorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but such publication is not to be construed as official approval of the views expressed.

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SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING AUGUST, 1918.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Weather Bureau, Washington, D. C., Oct. 2, 1918.]

For a description of instrumental exposures, and an account of the methods of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1918, **46**:2.

The monthly means and departures from normal values given in Table 1 show that direct solar radiation averaged above normal at Washington, D. C., and Lincoln, Nebr., very close to normal at Santa Fe, N. Mex., and slightly below normal at Madison, Wis.

Morning measurements made at Madison after the 26th have not been included, as a defect in the pyrheliometer leads was discovered later that cast doubt upon the accuracy of the morning readings after that date. For the reason given in connection with the July report, less than the usual number of readings were obtained at Lincoln during the current month.

Table 3 shows only unimportant departures from the normal for the month at Madison, and deficiencies of about 3 per cent at Washington and Lincoln.

Skylight polarization measurements at Washington on four days give a mean of 57 per cent with a maximum of 62 per cent on the 23d. Measurements at Madison on eight days give a mean of 62 per cent with a maximum of 71 per cent on the 31st. These readings are slightly above the average for the respective stations.

TABLE 1.—*Solar radiation intensities during August, 1918.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Aug. 12	1.21	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	1.25	1.00	0.80	0.70	0.61	0.54	0.50	0.45	.....	.....
15	1.25	1.11	1.00	0.90	.....	.....	.....	.....	.....	.....
16	.....	1.13	1.00	0.89	0.80	.....	.....	.....	.....	.....
21	1.46	1.35	1.25	1.16	1.08	.....	.....	.....	.....	.....
23	1.05	.....	0.74	0.67	0.61	.....	.....	.....	.....	.....
Monthly means	**1.24**	**1.15**	**0.96**	**0.86**	**0.78**	**(0.54)**	**(0.50)**	**(0.45)**	.....	.....
Departure from 10-year normal	**±0.00**	**+0.08**	**+0.06**	**+0.04**	**+0.04**	**−0.10**	**−0.04**	**−0.08**	.....	.....
P. M.										
Aug. 15	.....	1.19	1.10	1.02	0.94	0.87	0.80	0.74	0.68	.....
21	.....	.....	1.23	1.12	1.03	.....	.....	.....	.....	.....
Monthly means	.....	**(1.19)**	**(1.16)**	**(1.07)**	**(0.98)**	**(0.87)**	**(0.80)**	**(0.74)**	**(0.68)**	.....
Departures from 10-year normal	.....	**+0.10**	**+0.19**	**+0.22**	**+0.21**	**+0.21**	**+0.21**	**+0.21**	**+0.14**	.....

TABLE 1.—*Solar radiation intensities during August, 1918*—Contd.

Madison, Wis.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Aug. 6	1.12	1.05	0.92	0.85	0.77	0.70	0.63	0.57	.....	.....
13	1.16	1.05	0.94	0.85	0.77	0.68	0.62	0.56	.....	.....
19	1.39	1.27	.....	.....	.....	.....	.....	.....	.....	.....
24	1.39	1.29	.....	.....	.....	.....	.....	.....	.....	.....
25	.....	.....	.....	.....	0.95	.....	0.82	.....	.....	.....
26	1.45	.....	.....	.....	.....	0.89	0.83	0.77	.....	.....
Monthly means	**1.30**	**1.16**	**(0.93)**	**(0.85)**	**0.83**	**0.76**	**0.73**	**0.63**	.....	.....
Departure from 8-year normal	**−0.01**	**−0.02**	**−0.15**	**−0.15**	**−0.08**	**−0.12**	**−0.08**	**−0.15**	.....	.....
P. M.										
Aug. 22	.....	1.05	.....	.....	.....	.....	.....	.....	.....	.....
26	.....	1.30	1.16	1.08	1.01	0.94	0.87	0.82	0.77	0.73
Monthly means	.....	**(1.18)**	**(1.16)**	**(1.08)**	**(1.01)**	**(0.94)**	**(0.87)**	**(0.82)**	**(0.77)**	**(0.73)**
Departure from 8-year normal	.....	**+0.03**	**+0.14**	**+0.13**	**+0.16**	**+0.14**	**+0.07**	**+0.06**	**+0.16**	**+0.03**

Lincoln, Nebr.

A. M.										
Aug. 13	.....	1.20	1.09	.....	.....	.....	.....	.....	.....	.....
26	1.47	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	.....	1.15	1.04	.....	.....	.....	.....	.....	.....	.....
31	1.40	1.28	1.17	1.08	1.00	0.93	0.86	0.79	.....	.....
Monthly means	**(1.44)**	**1.21**	**1.10**	**(1.08)**	**(1.00)**	**(0.93)**	**(0.86)**	**(0.79)**	.....	.....
Departure from 4-year normal	**+0.10**	**+0.02**	**+0.02**	**+0.09**	**+0.10**	**+0.07**	**+0.05**	**+0.05**	.....	.....
P. M.										
Aug. 12	.....	.....	.....	.....	.....	.....	.....	0.67	0.61	0.56
26	.....	1.37	1.27	1.17	1.08	1.02	0.96	0.90	0.85	0.80
29	.....	1.00	0.89	.....	0.68	0.59	0.51	0.44	0.40	0.37
31	.....	.....	1.19	1.10	1.00	.....	.....	.....	.....	.....
Monthly means	.....	**(1.18)**	**1.12**	**(1.14)**	**0.92**	**(0.80)**	**(0.74)**	**0.67**	**0.62**	**0.58**
Departure from 4-year normal	.....	**−0.02**	**+0.02**	**+0.12**	**±0.00**	**−0.05**	**−0.03**	**−0.07**	**−0.10**	**−0.11**

Santa Fe, N. Mex.

A. M.										
Aug. 1	1.39	1.29	1.21	1.13	1.05	0.98	0.92	0.87	0.84	.....
2	.....	.....	.....	1.03	0.94	.....	.....	.....	.....	.....
3	1.38	1.26	1.16	1.07	0.99	.....	0.88	.....	.....	.....
5	.....	.....	1.19	1.13	.....	.....	.....	.....	.....	.....
9	.....	.....	.....	1.06	1.02	0.94	0.86	.....	.....	.....
10	.....	.....	.....	.....	.....	.....	.....	0.82	.....	.....
13	.....	1.28	1.23	.....	.....	.....	.....	.....	.....	.....
15	1.39	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	.....	1.34	1.19	.....	.....	0.99	0.92	0.87	0.81	.....
23	.....	1.38	1.25	1.19	1.10	1.02	0.94	.....	.....	.....
26	.....	1.35	1.26	.....	.....	.....	0.97	.....	.....	.....
27	.....	1.27	1.27	1.17	1.11	1.05	1.00	0.95	0.90	.....
29	1.42	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	1.09	1.02	0.92	0.84	.....	.....	.....	.....
Monthly means	**1.40**	**1.31**	**1.21**	**1.10**	**1.02**	**0.97**	**0.93**	**0.88**	**0.85**	.....
Departures from 6-year normal	**−0.02**	**−0.01**	**−0.01**	**−0.04**	**−0.05**	**−0.04**	**−0.02**	**−0.04**	**−0.07**	.....
P. M.										
Aug. 19	.....	1.40	.....	.....	.....	1.09	.....	.....	.....	.....
23	.....	1.45	1.32	1.24	1.16	1.10	1.04	0.99	.....	.....
Monthly means	.....	**(1.42)**	**(1.32)**	**(1.24)**	**(1.16)**	**(1.10)**	**(1.04)**	**(0.99)**	.....	.....

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D, C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Dates.	a. m.	p. m.	Dates.	a. m.	p. m.	Dates.	a. m.	p. m.	Dates.	a. m.	p. m.
1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*
Aug. 12	19.89	21.28	Aug. 6	14.10	15.11	Aug. 12	13.13	23.52	Aug. 1	7.87	9.83
14	19.23	19.89	13	16.20	16.79	13	17.37	15.11	2	7.87	7.87
15	12.68	12.68	19	11.38	10.59	26	11.38	7.29	3	7.29	6.27
16	13.13	15.11	22	17.96	19.23	29	8.48	14.10	5	6.27	7.29
21	11.38	13.61	24	15.11	12.24	31	7.04	7.57	9	10.59	7.87
23	14.60	16.20	25	13.13	13.13	.....	.....	.....	10	7.87	10.59
.....	.....	.....	26	13.13	9.83	.....	.....	.....	13	8.48	10.59
.....	.....	.....	.....	.....	.....	.....	.....	.....	15	7.87	7.87
.....	.....	.....	.....	.....	.....	.....	.....	.....	17	9.83	7.29
.....	.....	.....	.....	.....	.....	.....	.....	.....	19	5.79	6.76
.....	.....	.....	.....	.....	.....	.....	.....	.....	23	9.14	4.75
.....	.....	.....	.....	.....	.....	.....	.....	.....	26	7.29	9.83
.....	.....	.....	.....	.....	.....	.....	.....	.....	27	6.02	6.02
.....	.....	.....	.....	.....	.....	.....	.....	.....	29	7.29	10.59
.....	.....	.....	.....	.....	.....	.....	.....	.....	30	7.87	8.48

TABLE 3.—*Daily totals and departures of solar and sky radiation during August, 1918.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Aug. 1	480	425	651	− 3	− 50	115	− 3	− 50	115
2	467	545	627	− 15	72	94	− 18	22	209
3	477	573	627	− 4	102	96	− 22	124	305
4	314	286	663	−166	−183	135	− 188	− 59	440
5	542	495	614	63	28	88	− 125	− 31	528
6	533	588	571	56	124	48	− 69	93	576
7	476	489	215	2	27	−304	− 67	120	272
8	536	375	294	65	− 84	−222	− 2	36	50
9	463	538	306	− 5	81	−206	− 7	117	−156
10	296	475	574	−169	21	65	− 176	138	− 91
11	383	258	415	− 79	−193	− 90	− 255	− 55	−181
12	503	552	613	44	104	111	− 211	49	− 70
13	440	509	431	− 16	64	− 67	− 227	113	−137
14	503	573	287	50	130	−208	− 177	243	−345
15	609	411	447	159	− 29	− 44	− 18	214	−389
16	575	77	521	128	−361	33	110	−147	−356
17	126	121	315	−318	−314	−169	− 208	−461	−525
18	84	499	520	−356	67	39	− 564	−394	−486
19	525	593	525	88	163	57	− 476	−231	−429
20	543	429	360	109	2	−115	− 367	−229	−544
Decade departure							− 191	−367	−453
21	593	365	590	162	− 60	118	− 205	−289	−426
22	437	532	405	9	110	− 64	− 196	−179	−490
23	500	243	389	75	−177	− 77	− 121	−356	−567
24	574	558	564	152	141	101	31	−215	−466
25	500	504	474	80	90	14	111	−125	−452
26	400	565	599	− 18	154	131	93	29	−321
27	412	478	521	− 4	70	66	89	99	−255
28	89	283	358	−325	−122	− 95	− 236	− 23	−350
29	372	527	542	− 40	125	92	− 276	102	−258
30	422	297	142	12	−102	−306	− 264	0	−564
31	338	548	614	− 70	152	168	− 334	152	−396
Decade departure							+ 33	+381	+148
Excess or deficiency since first of year (Gr.-cal.)							−1,266	+938	+276
Excess or deficiency since first of year (Per cent.)							− 1.3	+1.0	+0.2

VOLCANIC ERUPTIONS AND SOLAR RADIATION INTENSITIES.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., Sept. 13, 1918.]

In previous papers[1] curves have been presented showing variations in the annual mean values of solar radiation intensity at a few stations, for the period 1883–1912. These have been quoted by different writers,[2] and it now seems advisable to bring them up to date, since the last curve published ends in the midst of the depression of 1912–13, following the eruption of Katmai Volcano, Alaska, in June, 1912.

In Table 1 there is given for each station the month and year of the beginning and ending, and reference to a footnote gives the character, of the data utilized in constructing this new curve. The data for some of the stations is not complete. For example, at Simla, India, radiation measurements are rarely obtained in July or August. At Mount Weather, Va., the records were fragmentary until May, 1911, and the same is true of the early part of the records at Madison, Wis., and Santa Fe, N. Mex. The records of these two latter stations were not employed previous to 1914, except in determining the monthly normals for these stations.

TABLE 1.—*Duration and character of solar radiation intensity records.*

Year.	Montpellier, France.	Lausanne, Switzerland.	Pavlovsk, Russia.	Warsaw, Poland.	Washington, D. C.	Simla, India.	Paris, France.	Mount Weather, Va.	Madison, Wis.	Santa Fe, N. Mex.	Lincoln, Nebr.	Total number of stations.
1882	Dec.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1883	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1884	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1885	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1886	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1887	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1888	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1889	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1890	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1891	×	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1892	×	.....	Sept	.....	.....	.....	.....	.....	.....	.....	.....	2
1893	×	.....	+	.....	.....	.....	.....	.....	.....	.....	.....	1
1894	×	.....	+	.....	.....	.....	.....	.....	.....	.....	.....	1
1895	×	.....	+	.....	.....	.....	.....	.....	.....	.....	.....	2
1896	×	Jan.	+	.....	.....	.....	.....	.....	.....	.....	.....	3
1897	×	×	+	.....	.....	.....	.....	.....	.....	.....	.....	3
1898	×	×	+	.....	.....	.....	.....	.....	.....	.....	.....	3
1899	×	×	+	.....	.....	.....	.....	.....	.....	.....	.....	3
1900	Dec.	×	+	.....	.....	.....	.....	.....	.....	.....	.....	3
1901	.....	×	+	Jan.	.....	.....	.....	.....	.....	.....	.....	3
1902	.....	×	+	+	.....	.....	.....	.....	.....	.....	.....	3
1903	.....	×	+	+	.....	.....	.....	.....	.....	.....	.....	3
1904	.....	Aug.	+	+	.....	.....	.....	.....	.....	.....	.....	3
1905	.....	.....	+	+	June	.....	.....	.....	.....	.....	.....	3
1906	.....	.....	+	+	○	Oct.	.....	.....	.....	.....	.....	4
1907	.....	.....	+	+	○	×	Jan.	Sept.	.....	.....	.....	6
1908	.....	.....	+	+	○	×	+	○	.....	.....	.....	6
1909	.....	.....	+	+	○	×	+	○	.....	.....	.....	6
1910	.....	.....	+	+	○	×	+	○	(July)	.....	.....	6
1911	.....	.....	+	+	Aug.	×	+	○	(○)	.....	.....	6
1912	.....	.....	+	+	.....	×	+	○	(○)	(Oct.)	.....	5
1913	.....	.....	Apr.	Aug.	.....	×	Dec.	○	(○)	(○)	.....	5
1914	.....	.....	.....	.....	Oct.	×	.....	Sept.	○	○	.....	4
1915	.....	.....	.....	.....	○	Dec.	.....	.....	○	○	July	5
1916	.....	.....	.....	.....	○	.....	.....	.....	○	○	○	4
1917	.....	.....	.....	.....	○	.....	.....	.....	○	○	○	4
1918	.....	.....	.....	.....	July	.....	.....	.....	July	July	July	4

×=monthly means of noon solar radiation intensities.
+=monthly maxima of solar radiation intensities.
○=monthly means of solar radiation intensities with the sun at zenith distance 60°.
(○)=data inclosed in curves employed only in completing the monthly normals of the respective stations.

For stations in the United States the monthly normal has been obtained by dividing the sum of all the radiation intensities measured in the months of a given name by the total number of measurements. For the other stations it has been necessary to take the average of the monthly means for the monthly normal.

The monthly means or the monthly maxima for each station have next been expressed as a percentage of either the monthly normal or the average monthly values, and the mean of the percentages for all the stations determined for each month. These monthly means have been smoothed by the formula $\frac{a+2b+c}{4}$, where b is the mean for the month in question, and a and c are the means for the preceding and following months, respectively.

[1] *Kimball, Herbert H.* Bulletin of the Mount Weather Observatory, 3:111; 5:301.

[2] *Humphreys, W. J.* Volcanic dust and other factors in the production of climatic changes, and their possible relation to the ice ages. Bulletin of the Mount Weather Observatory, 6:1–34.
Abbot, C. G., & Fowle, F. E. Volcanoes and climate. Annals of the Astrophysical Observatory of the Smithsonian Institution, 3:211–229.

The smoothed percentages thus obtained have been plotted as dots on figure 1.

Reference to Table 1 shows that for the period December, 1882–August, 1892, data were available for a single station only, and from September, 1892, to December, 1895, from two stations only. In consequence the monthly values are much more scattering previous to 1896, and especially previous to 1893, than subsequent to these years.

Furthermore, all the radiation measurements previous to 1905 were made at noon only. It follows from the Bouguer equation [3] that the percentage of depletion due to diminished transmissibility of the atmosphere, or the percentage increase due to increased atmospheric transmission, would be greater during the winter months, when the sun's zenithal distance is at a maximum, than in the summer months, when it is at a minimum. There is evidence of this annual variation in the radiation intensities, particularly in the early part of the curve.

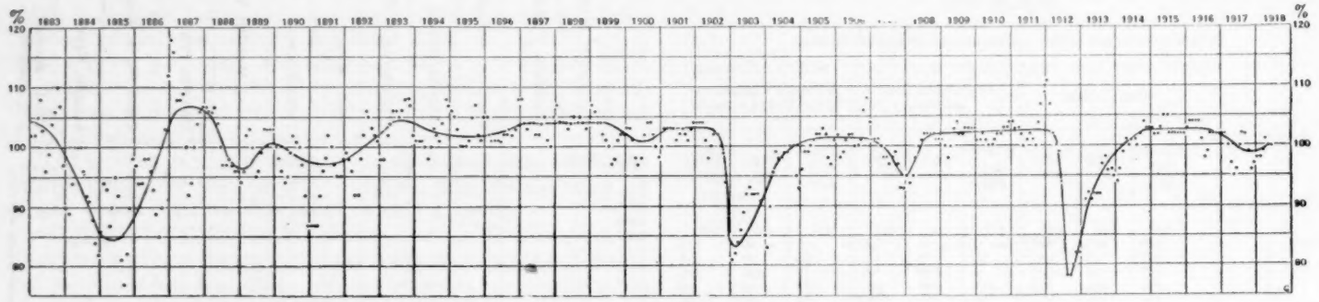


FIG. 1.—Monthly averages of solar radiation intensity at earth's surface, expressed as percentages of the monthly normals.

This has been taken into account in drawing a free-hand curve through the plotted values.

As previously shown,[4] the three great depressions in the curve of figure 1 follow the great eruptions of Krakatoa in the summer of 1883; of Pelée, Santa Maria, and Colima, in 1902, and of Katmai in June, 1912. In each case there has been complete recovery—in the case of Krakatoa, after 34 months, of Pelée after 17 months, and of Katmai, after 21 months. There are minor depressions in 1888–89 and in 1907–8 that have not been accounted for definitely, and also one in 1916–17 that may be due to the fact that since the outbreak of the European war it has been necessary to substitute data from stations in the United States for that previously obtained from stations in Europe. In consequence, the data are not so representative of conditions in the Northern Hemisphere as a whole, but are more influenced by local atmospheric conditions. Aside from the depressions noted, the smoothed monthly radiation intensities show remarkably uniform values. It is because the values obtained during the great depressions have been included in the means that the intensities measured under normal conditions generally fall between 102 and 104 per cent.

The following are the sources of the solar radiation data that have been utilized:

MONTPELLIER, FRANCE. **Eon, L. J.** Intensités calorifiques de la radiation solaire et durée de l'insolation a Montpellier. (Année 1900 et résumé de la série 1883–1900.) (*In* Bulletin météorologique du Départment de l'Hérault, année 1900. Montpellier. 1901.)

LAUSANNE, SWITZERLAND. **Bührer, C. & Dufour, Henri.** Résumé des observations actinométriques de l'année 1903. (Arch. sci. phys. nat., Genève. 4 pér. Tome **19.** 1905. p. 388–390.) **Dufour, Henri.** L'insolation en Suisse. 1 partie. (Arch. sci. phys. nat., Genève. 4 pér. Tome 16. 1903. p. 417–434.) **Dufour, Henri &** **Bührer, C.** L'insolation en Suisse. 2 partie. (Arch. sci. phys. nat., Genève. 4 pér. Tome **16.** p. 526–540.)

PAVLOVSK, RUSSIA. **Savinov, S. I.** [The maximum of solar radiation at Pavlovsk since 1892. The decrease in the intensity during the second half of 1912]. [Russian.] Bull., Ac. Imp. des. sci., St. Pétersbourg, 6 me sér., 1913, No. **12,** p. 707–720.

WARSAW, POLAND. **Gorczynski, Ladislav.** Valeurs pyrhéliométriques et les sommes d'insolation à Varsovie pendant la période 1901–1913. Varsovie, 1914.

WASHINGTON, D. C. Bulletin of the Mount Weather Observatory, **3:**85–96; **5:**182, 302, 303; Monthly Weather Review, 1914, **42:**648; 1915, **43:**112. [Monthly thereafter.]

SIMLA, INDIA. Indian Monthly weather review, 1906–15.

PARIS (PARC ST. MAUR), FRANCE. La Nature (Paris), Supplément, années 35–42, 1907–1914.

MOUNT WEATHER, VA. Bulletin of the Mount Weather Observatory, **5:**303–311; **6:**215–219. Monthly Weather Review, 1914, **42:**139, 310, 520.

MADISON, WIS. Bulletin of the Mount Weather Observatory, **5:**173–183. Monthly Weather Review, 1916, **44:**3, 9–12. [Monthly thereafter.]

SANTA FE, N. MEX. Monthly Weather Review, 1915, **43:**439–443, 591. [Monthly thereafter.]

LINCOLN, NEBR. Monthly Weather Review, 1916, **44:**4–8. [Monthly thereafter.]

[3] $I = I_0 a^m$, where I_0 is the radiation intensity outside the atmosphere, a is the transmission coefficient of the atmosphere, or the proportional part of the radiation transmitted when the sun is in the zenith, m is the length of the path of the sun's rays through the atmosphere in terms of the length of the path for zenithal sun, and I is the solar radiation intensity measured at the surface of the earth. This equation is strictly true for homogeneous rays only.

[4] *Kimball, H. H.* loc. cit. *Humphreys W. J.* loc. cit.

HALO PHENOMENA OBSERVED DURING AUGUST, 1918.

By WILLIS RAY GREGG, Meteorologist.

Halo phenomena observed during August, 1918.

Station.	Altitude.	Latitude.	Longitude.	Date.	Form observed.	Time of—		Theodolite readings.					
						Beginning.	Ending.	Time.	Radius inside.	Radius outside.	Length of arc.	Distance from sun or moon.	Altitude of sun or moon.
	m.	° ′	° ′						°	°	°	°	°
Broken Arrow, Okla.*	233	36 02	95 49	3	Solar halo, 22°.	10:25 a. m.	3:30 p. m.	11:50 a. m.	21.5	22.2	360	.....	70.2
Canton, N. Y.	137	44 36	75 10	6	Solar halo, 22°.	12:00 m.	12:40 p. m.	.....	.....	.....	.....	.....	.....
				7	Solar halo, 22°.	7:30 a. m.	1:00 p. m.	.....	.....	.....	.....	.....	.....
				16	Lunar halo, 22°.	9:30 p. m.	10:30 p. m.	.....	.....	.....	.....	.....	.....
				22	Solar halo, 22°.	1:45 p. m.	3:00 p. m.	.....	.....	.....	.....	.....	.....
				22	Lunar halo, 22°.	10:00 p. m.	.....	.....	.....	.....	.....	.....	.....
				30	Solar halo, 22°.	1:35 p. m.	2:30 p. m.	.....	.....	.....	.....	.....	.....
Cincinnati, Ohio	191	39 06	84 30	None.		.....	.....	.....	.....	.....	.....	.....	.....
Dayton, Ohio	274	39 46	84 10	None.		.....	.....	.....	.....	.....	.....	.....	.....
Drexel, Nebr.*	396	41 20	96 16	None.		.....	.....	.....	.....	.....	.....	.....	.....
Ellendale, N. Dak.*	444	45 59	98 34	2	Solar halo, 22°.	1:10 p. m.	1:25 p. m.	.....	.....	.....	.....	.....	.....
				3	Solar halo, 22°.	8:00 a. m.	8:35 a. m.	8:10 a. m.	.....	.....	100	.....	28
				23	Solar halo, 22°.	7:15 a. m.	8:00 a. m.	.....	.....	.....	.....	.....	.....
Groesbeck, Tex.*	141	31 30	96 28	6	Solar halo, 22°.	10:40 a. m.	6:48 p. m.	10:47 a. m.	22	24	360	.....	63
				6	Upper tangent arc.	4:13 p. m.	4:27 p. m.	4:15 p. m.	.....	.....	20	22	37
				6	Lower tangent arc.	4:00 p. m.	4:20 p. m.	4:02 p. m.	.....	.....	10	23	40
				7	Solar halo, 22°.	11:15 a. m.	12:37 p. m.	11:26 a. m.	22	23	360	.....	69
Leesburg, Ga.*	85	31 47	84 14	None.		.....	.....	.....	.....	.....	.....	.....	.....
Madison, Wis.	297	43 05	89 23	5	Solar halo, 22°.	9:40 a. m.	10:00 a. m.	.....	.....	.....	.....	.....	.....
				7	Solar halo, 22°.	7:50 a. m.	9:00 a. m.	.....	.....	.....	.....	.....	.....
				9	Solar halo, 22°.	12:30 p. m.	.....	.....	.....	.....	.....	.....	.....
				21	Solar halo, 22°.	7:00 a. m.	9:00 a. m.	.....	.....	.....	.....	.....	.....
Nashville, Tenn.	166	36 10	86 47	None.		.....	.....	.....	.....	.....	.....	.....	.....
Royal Center, Ind.*	227	40 53	86 29	27	Solar halo, 22°.	8:42 a. m.	12:30 p. m.	.....	.....	.....	.....	.....	.....
				30	Solar halo, 22°.	11:45 a. m.	12:15 p. m.	.....	.....	.....	.....	.....	.....

Station.	Date.	Colors.**	Degree of brightness.	Clouds.			Station pressure.	Precipitation.	
				Amount.	Kind.	Direction.		Last previous ended.	First subsequent began.
Broken Arrow, Okla.*	3	Y.	Dim.	6	Ci. St.	s.	Falling.	9:00 p. m., 25th.	D. N. p., 7th.
Canton, N. Y.	6	.....	.....	1	Ci. St.	w.	Rising.	8:00 a. m., 6th.	8:00 p. m., 6th.
	7	O. Y. G.	Dim.	2	Ci. St.	w.	Stationary.	8:00 p. m., 6th.	8:32 p. m., 7th.
	16	R. O. Y. G. B.	Dim.	1	Ci. St.	w.	Stationary.	9:50 a. m., 14th.	9:27 p. m., 21st.
	22	O. Y. G.	Dim.	1	Ci. St.	w.	Falling.	9:27 p. m., 21st.	D. N. a., 24th.
	22	R. O. Y. G.	Dim.	4	Ci. St.	w.	Falling.	9:27 p. m., 21st.	D. N. a., 24th.
	30	R. O. Y. G.	Dim.	2	Ci. St.	w.	Falling.	8:00 p. m., 29th.	8:00 a. m., 31st.
Cincinnati, Ohio	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dayton, Ohio	.....	.....	.....	.....	.....	.....	.....	.....	.....
Drexel, Nebr.*	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ellendale, N. Dak.*	2	R.	Dim.	8	Ci. St.	nnw.	Falling.	10:50 p. m., 31st.	3:05 p. m., 2d.
	3	R.	Dim.	3	Ci. St.	nw.	Falling.	4:10 p. m., 2d.	6:10 p. m., 3d.
				4	A. St.	nw.			
	23	.....	Bright.	2	Ci. St.	w.	Rising.	12:00 m., 21st.	6:30 p. m., 23d.
				3	A. St.	w.			
Groesbeck, Tex.*	6	R. O. Y. G. B. I. V.	Brilliant.	8	Ci. St.	s.	Falling.	4:29 p. m., 5th.	12:48 p. m., 8th.
	6	R. O. Y. G. B. I. V.	Bright.	8	Ci. St.	n.	Falling.	4:29 p. m., 5th.	12:48 p. m., 8th.
	6	R. O. Y. G. B. I. V.	Bright.	8	Ci. St.	n.	Falling.	4:29 p. m., 5th.	12:48 p. m., 8th.
	7	O. Y. G. B.	Dim.	8	Ci. St.	se.	Falling.	4:29 p. m., 5th.	12:48 p. m., 8th.
Leesburg, Ga.*	.....	.....	.....	.....	.....	.....	.....	.....	.....
Madison, Wis.	5	R.	Bright.	10	Ci. St.	nw.	Stationary.	11:30 a. m., 4th.	9:00 a. m., 8th.
	7	R.	Bright.	3	Ci. St.	nw.	Stationary.	11:30 a. m., 4th.	9:00 a. m., 8th.
				Few.	Cu.	.....			
	9	O.	Brilliant.	5	Ci. St.	sw.	Falling.	9:30 a. m., 8th.	8:02 a. m., 10th.
	21	R.	Bright.	5	Ci. St.	nw.	Stationary.	5:22 p. m., 17th.	7:00 p. m., 22d.
				5	A. St.	nw.			
Nashville, Tenn.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Royal Center, Ind.*	27	R. B.	Dim.	4	Ci. St.	sw.	Falling.	4:30 p. m., 28th.	5:10 a. m., 28th.
	30	R. B.	Dim.	7	Ci. St.	w.	Falling.	10:50 a. m., 30th.	D. N. p., 30th.

*Aerological station.

** Beginning with part nearest sun or moon. R, red; O, orange; etc.

SOUTH CAROLINA METEOR OF APRIL 23, 1918.

By RICHARD H. SULLIVAN, Meteorologist.

[Dated: Weather Bureau Office, Columbia, S. C., June 5, 1918.]

A remarkable meteoric phenomenon was witnessed throughout South Carolina and portions of adjacent States between 7.20 and 7.42 p. m., Eastern Standard (75th Mer.) Time, on April 23, 1918.

The meteor came out of the firmament from the north like a flash of lightning, and exploded with three distinct prongs of light like an immense skyrocket. It cast a noticeable glare on the twilight, and left a cloud of whitish-gray smoke or cosmic dust suspended aloft similar in many respects to a cloud from a shrapnel shell or aerial dynamite bomb. The position of the meteor at the time of explosion, as closely as could be ascertained, was as follows: As viewed from Charlotte, N. C., altitude 65°, azimuth 60°; Charleston, S. C., altitude 10°, azimuth 155°; Columbia, S. C., altitude 30°, azimuth 172°.

The cosmic cloud apparently remained stationary for 22 minutes, and during this period the wind velocity at the earth's surface ranged from 8 to 10 miles per hour from the southwest. After the explosion the length of the cloud appeared to be about twice the apparent diameter of the full moon, and its width about half its length. Its position in the sky appeared to be east and west, and it was so high that reflections from the far-set

sun were very pronounced, particularly on two of the denser portions of the dissipating dust. The cloud disintegrated into several parts, and spread out laterally and downward toward the east and west. Apparently it did not come fully under the influence of the forward movement of the atmosphere until about nine minutes after the explosion, and this would indicate a very thin, rarefied condition aloft.

Reports of detonations from the explosion, covering many points in the central and northern parts of the State, range from 1 to 10 minutes after the phenomenon was observed, with an average of about 3 minutes. Several observers reported two or three distinct explosive sounds, resembling distant thunder.

Observations indicate that the explosion of the meteor occurred over a point in southeastern Cherokee County, somewhat to the southward of the village of Wilkinsville, possibly near the junction of Gilkins and Thickety Creeks.

NOTE.

In his complete report of this meteor Mr. Sullivan presents a large amount of data, including more than a hundred observations of its direction, and a few fairly accurate azimuth readings, as already noted. These all agree very closely in locating the section of the country above which the meteor appeared. Unfortunately no instrumental, and only a few eye observations, of altitude angles were obtained, and among these there is considerable discrepancy. Probably the most complete and reliable record of the movement of the meteor cloud was made by Mr. J. W. Ruff, industrial power engineer of the Charleston Consolidated Railway & Lighting Co. His observations were made by eye, but were later verified by a transit, using certain objects, such as trees, house tops, etc., as references. These readings, and some that have been furnished by other observers, indicate that at the time of explosion the meteor was at an altitude of practically 95 kilometers. Soon after this time the cloud was apparently about 2 kilometers long and 1 kilometer wide.

There seems to have been some conflict of opinion as to whether the cloud actually moved or not; but at the height computed above even a considerable movement might take place without being noticed, unless the observer was using an instrument. Summarizing the collected data, and giving greatest weight to that furnished by Mr. Ruff, it is evident that the cloud had a very marked eastward movement, averaging during its visibility about 250 kilometers per hour. The lower portion moved more rapidly than the upper, the difference in velocity being about 5 kilometers per hour for each change in altitude of 1 kilometer. At the time of disappearance the cloud was about 12 kilometers long and less than half as wide, with a depth of about 7 kilometers. During its visibility the denser portions settled about 8 kilometers and the lighter portions but a few kilometers, showing that, even at that height, the light particles were held practically in suspension by the rarefied air. Its final disappearance was probably due to its dissipation and to the passing above it of the rays of the far-set sun.

Meteoric observations are of value to the meteorologist chiefly because they furnish information concerning the height of the atmosphere and the direction and velocity of motion of the air at great altitudes. The successful reduction and practical use of such observations depend upon the accuracy and number of observations of the altitude and azimuth angles. The altitude angle, preferably measured with an instrument, or at least checked by an instrument, is of prime importance. The angle should be read at some definite time or times, for example, at first and last appearance, or at some definite point in the meteor's path. If the meteor leaves a visible trail or cloud it is very desirable to have as many successive readings of its altitude and azimuth angles as possible, so that its movement may be accurately plotted.

In collecting data on such a phenomenon a scheme similar to the one used by Mr. Sullivan seems worthy of adoption. It consists in arranging the information gathered from all sources in tabular form under the following headings:

1. Position of the observer.
2. Altitude and azimuth readings (also whether by eye or instrument).
3. Time of occurrence, or of appearance and disappearance.
4. Brief description of phenomenon.
5. Accompanying phenomena, and any other notes.
6. Name of observer.

If the phenomenon attracts considerable attention, enough entries under each of these headings can probably be obtained so that their reduction will add materially to our knowledge of the movements of the atmosphere at heights where observations by any other means are impossible.— *W. S. Cloud.*

SECTION II.—GENERAL METEOROLOGY.

PHOTOMICROGRAPHS OF SNOW CRYSTALS, AND METHODS OF REPRODUCTION.

By WILLIAM A. BENTLEY.

[Dated: Jericho, Vt., August, 1918.]

The writer has noted some recent German criticisms [1] of his photomicrographs of snow crystals, in which he is accused of having in some cases "greatly retouched them," or "mutilated their outlines." Such criticisms seem unfair and unjust, in view of the fact that those making them know, through personal correspondence with the writer or otherwise, that nearly all his original snow-crystal images have been preserved absolutely untouched, and are available for comparison with the copies the writer has cut out in relief for the use of educational institutions and for publication.

Of the 3,000 photomicrographs of snow crystals obtained, absolutely untouched images of at least 2,500 have been preserved. Copies of the earlier specimens were not made for reproduction purposes, and this is also true of a few later specimens of plain outline or of inferior interest. As was to be expected in so large a collection, a few originals have been broken.

The writer feels that his photomicrographs of snow crystals are so well known, and have been so minutely examined and studied both by scientists and the general public, that no statement or argument is needed to preserve their reputation. Certainly no American meteorologist or scientist who is intimately acquainted with them, or who has seen them magnified tens of thousands of times when shown upon the screen, will believe that any of them can be correctly described as "greatly retouched" or "mutilated." The individuals and institutions that have studied the author's methods and his photomicrographs most closely are the most appreciative of the latter and the most enthusiastic in their use.

The writer fully appreciates Dr. Hellmann's eminent services to meteorology and to general knowledge, but he has no sympathy with that perverted or ultrascientific viewpoint that insists on having a photograph presented exactly as it emerges from the chemical bath, with all the false light impressions of dust and other foreign particles glaringly in evidence and falsifying the result. A true scientist wishes above all things to have his photographs "as true to Nature" as possible; and if retouching will help in this respect, then is it fully justified. It occasionally happens in snow-crystal work that dust particles or particles of snow-crystal débris fall upon the faces of the tabular crystals and can not be removed. These foreign particles may cover and hide from view important details, and in any event will mar the beauty and falsify the image of the snow crystal. Hence they should be retouched out as far as available means permits.

A recent English translation of Dr. Hellmann's "System der Hydrometeore" [2] having again brought the snow crystals to the attention of the readers of the MONTHLY WEATHER REVIEW, the writer feels that a brief statement of his methods, and the difficulties to be overcome in securing natural and true-to-nature photomicrographs of these exquisite yet evanescent objects, may be timely and of interest.

The chief photomicrographic difficulties may be grouped under the heads of "Transparency," "Evaporation," and "Snow débris."

TRANSPARENCY.

Snow crystals, though often extremely transparent, possess sharp outlines and present a white appearance to the unaided eye, because their numerous facets brilliantly reflect the light. In a photomicrograph, however, the transparency of the main body of the crystal makes it assume the tint of whatever background it may be projected upon, thus rendering it inconspicuous, often lacking in clearness of outline, and unnatural in appearance. There seems, indeed, no purely photographic method of reproducing such crystals clearly and naturally and beautifully. The writer's studies, however, led to an intense love for these marvellous crystals. He felt that a way *must* be found to reproduce them in all their unrivalled beauty, with sharp outlines, white upon a dark ground. It was soon noted that when viewed under a pocket lens their outlines in the negatives were sufficiently well defined to permit their being followed with the point of a penknife. So the "blocking out" method was tried, cutting the film of the negative away from the snow crystal image, and, although exceedingly tedious, it has proved to be an ideal method. All the more beautiful specimens among our 3,000 snow photomicrographs have been treated in this way. The writer feels strongly that whatever microscopic exactness of outline is lost thereby is made up manyfold by the greater naturalness and sharpness of outline and enhanced beauty of the snow crystal images produced by this method.

The whole method is portrayed photographically in photographs No. 890 (A), 890 (B), 2681 (A), and 2681 (B), reproduced on Plate 1. No. 980A is reproduced from a print from the original untouched negative. No. 980B is reproduced from a print from this negative with the film surrounding the snow crystal image removed by the "blocking out" process. No. 2681A is also reproduced from a print from the untouched negative, and No. 2681B is reproduced from a print from this negative with half the film surrounding the snow crystal image removed by the "blocking out" system. It is to be noted that none of the fineness of detail of 890A or 2681A is lost in 890B or 2681B. On the contrary, the details stand out in greater clearness against the black background of 890B, and the left-hand half of 2681B.

However, the importance was early realized of preserving the original images untouched, as proof of the correctness to Nature of the work. This has been accomplished in two ways—(*a*) the original negatives have been preserved intact by making copy negatives from the originals and cutting the film away on these copies; or (b) a positive copy has been made on glass of the original negative before cutting away from around the image of the snow crystals thereon. The collection now includes about 1,500 original unchanged negatives and about 1,000 copied "positives," taken before the film

[1] *Hellmann, Gustav.* System der Hydrometeore. Berlin, 1915. (Veröffentl. d. K. preuss. Meteorol. Institut. Nr. 285; Abhandlgn. Bd. 5, Nr. 2).

[2] MONTHLY WEATHER REVIEW, July, 1916, 44: 385–392; and Jan. 1917, 45:13–16.

was cut away from around the snow image. The author's faith in the correctness of his work is shown by the fact that criticism has always been courted, and an effort has been made to have the Weather Bureau or some other institution take over the custody of the original negatives and positives of snow forms.

EVAPORATION.

An almost *ever present* difficulty in securing exact outline images of snow crystals arises from evaporation, and this is especially true of the *branchy* forms. Sometimes a slight wearing away of the crystals by evaporation occurs even before the crystals reach the earth. When they are placed apart on a glass slide evaporation usually proceeds rapidly, and the crystals last but a few minutes, or even seconds in some cases. Their outlines pass quickly through various changes of form, no two of which are alike. Evaporation ofttimes occurs in such a way as to intensify whatever lack of symmetry the mature crystal outline may have possessed. Points or parts that are slightly smaller than their neighbors, and usually also slightly thinner, evaporate the more rapidly. Moreover exterior deformation ofttimes occurs as a result of the grouping of separate crystals. For example, when placed for observation and photomicrographic purposes on a glass slide the outlying parts, or points projecting away from the group or away from a neighboring crystal, always evaporate much the more rapidly. For these reasons photomicrographs always tend to show snow crystals less beautiul and less symmetrical than they actually are in Nature. Doubtless Dr. Hellmann's conclusion that "it is rarely that ideally perfect crystals occur in Nature" is largely due to this fact, for many of the photomicrographs of snow crystals taken for him by Dr. Neuhauss to be used to illustrate his interesting book, "Schnee Krystalle,"[1] were deformed and robbed of much of their natural symmetry as a result of their being grouped together for photographic purposes. His plates I, III, and IV show this "deformation" in greatest degree.

Many of the writer's photomicrographs show a similar evaporative deformation, though great pains have been taken to guard against it. The results of this most interesting phenomenon are instructively shown in some of the photographs, and especially in Nos. 389 and 1887, Plate 1, both of which are photographs of crystals which were originally very perfect and symmetrical. It will be noted in these photographs that evaporation is retarded in greatest degree at the points of contact or near approach of one crystal to another, but that some retardation occurs even half way around the circumference of each neighboring crystal, as though some subtle interaction between them tended to retard evaporation. A possible explanation is that the initial evaporation is everywhere at a uniform rate, but the region immediately surrounding the points of near-contact of the crystals becomes more completely saturate than elsewhere, and hence subsequent evaporation therein undergoes a retardation.

That crystals possessing almost perfect symmetry undergo intensified evaporative deformation as a result of one half being slightly smaller and thinner than the opposite half, is interestingly shown in photographs No. 2513A and 2513B, Plate 2, which portray the same crystal. No. 2513B was taken after No. 2513A, and shows intensification of evaporative deformation.

[1] Hellmann, Prof. Dr. Gustav., Berlin, 1893.

SNOW DÉBRIS.

Ofttimes a given snowfall consists of a mixture of perfect crystals of average size, tiny immature crystals, and small particles of snow débris, etc. These latter collect upon and adhere to the perfect crystals and are not easily removed. Photograph No. 2330A, Plate 2, is a case in point. The tiny crystal attached to its face could not be removed. This specimen is simply marvelous as regards perfect symmetry and beauty of interior. Special efforts were therefore made to retouch out the image of the tiny "germ crystal," and with some degree of success, as shown in the second photograph, No. 2330B, Plate 2, cut out in relief. No. 2585A, Plate 2, is another case of this kind. After trying in vain to remove the snow débris adhering to the crystal, a photograph was made, followed by a second partially successful attempt at removal, and a second photograph, No. 2585B, Plate 2. But evaporation meanwhile had done its work, and removed many interesting exterior parts and greatly modified the crystal. So once again retouching from the the first image was tried, and with what success is shown in the last photograph of the series, No. 2585C, Plate 2, cut out in relief. These last examples doubtless come under Dr. Hellmann's description of being "unfortunately greatly retouched." The verdict as to whether retouching in such cases is justified or not is left to the reader.

CONCLUSION.

From the foregoing it will be seen that we can not always reproduce, even in the photographs, images of the snow crystals that show their outlines exactly as they were when leaving cloudland or alighting upon the earth. Yet a little thought will convince us that this impairs their value or interest but little, as ultimate (mature) outline represents but one (the final) stage in the formation of crystals that usually undergo a multitude of changes of form and outline from time to time as growth progresses from the nuclei outward.

The high regard in which these photomicrographs of snow crystals are held is shown by the fact that almost every university of note in the United States has a set of from one to several hundred for educational uses. The University of Wisconsin alone has 2,000 lantern slides, and Prof. B. W. Snow, who is exceedingly enthusiastic in the use of them, began making purchases in 1889. His lectures on snow crystals have become deservedly famous. The following are quotations from his letters to the writer. Writing in 1910 he says:

> President Van Hise has followed your work with the greatest interest, and he has taken an enjoyment in your slides equal to my own, and has expressed himself repeatedly as being thankful that you can do for the world of science the work you are doing, and make so beautiful a contribution to our knowledge of the world of Nature.

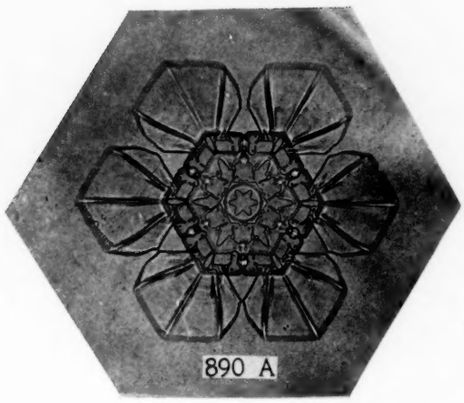
In 1915 he again writes:

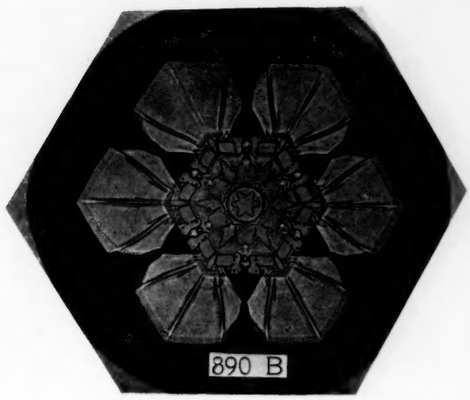
> You will not be surprised to hear that my own and the interest of my students increases each year, and that there is no one matter which I present during the entire year which brings such pleasure to my classes.

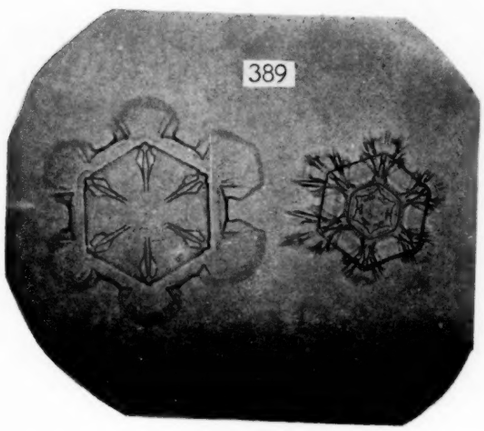
And again, in 1917, after receiving the 178 new photographs of the 1916–17 crop, he writes:

> All that I looked at are beautiful and give me the most exquisite pleasure, as they will do over and over again, as I shall see them repeatedly during the coming years. You are doing a great work in enabling students and scientists and people in many other walks of life to see and appreciate the infinity and prodigality as well as the beauty of nature.

To face page 360.







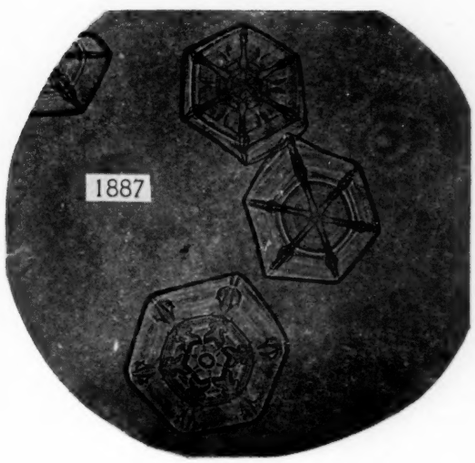
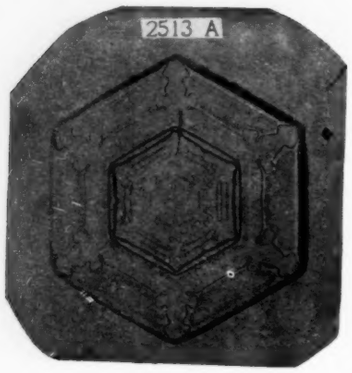
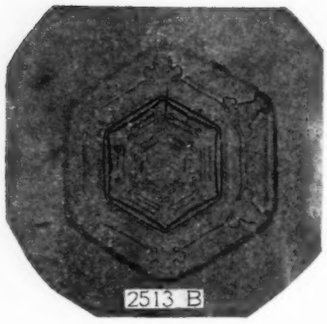


Plate 1.

To face page 361.]





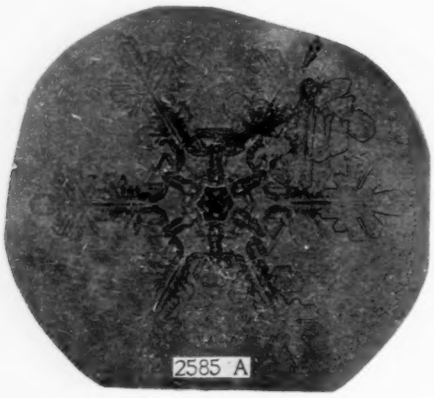


Plate 2.

HOT SPELL OF AUGUST, 1918.

By ALFRED J. HENRY, Meteorologist.

[Dated Washington, Sept. 14, 1918.]

The high temperatures of the first decade of August, 1918, came seemingly as a climax to a year of remarkable weather.

Beginning in October, 1917, a series of cold waves of unusual severity for the season swept far south over the Plains States, causing frost and freezing temperature in that month nearly to the Gulf coast. The winter of 1917–18 was marked by severe cold,[1] heavy snow, and ice.[2] Finally in August, 1918, the temperature rose to heights not hitherto attained in almost half a century of observations.

The writer of this paper made the official forecasts for the Washington district for August. While the hot spell was in progress it was a matter of continual surprise to him that, considering the pressure distribution, such abnormally high temperatures should persist day after day in some portions of the country. Records of maximum temperature that had stood for nearly half a century were not only broken, but the new record itself was in some cases exceeded on the following day. A retrospective view of the conditions preceding and during the prevalence of the high temperatures is helpful to a better understanding of the phenomenon than could be gained by the necessarily brief examination of the daily weather maps that was possible at the time; hence the preparation of this paper.

The use of summer time by the Weather Bureau has its disadvantages. The morning observation, coming an hour earlier than hitherto, gives current temperatures that are nearer the daily minimum in the greater portion of the country than formerly. Similarly, moving the evening observation forward an hour brings it that much nearer the hour of maximum temperature, so that in the Plains States there are but a few degrees separating the temperature at 7 p. m. 75th Meridian Time (5 p. m. to 6 p. m. Sun time) from the daily maximum. As a result the temperatures charted on the daily maps have been somewhat higher than have hitherto been charted under the same pressure conditions, and it has been more or less difficult, at times, to distinguish between abnormal heating due to cyclonic influences, and the apparent increase in temperature due to reading thermometers at an earlier hour in the afternoon.

Contributing causes.—In my judgment the high temperatures were the result of several influences acting in conjunction, viz: (1) The pressure distribution; (2) insolation, probably not exceptional in any respect, but unchecked by clouds for several consecutive days; (3) the topography of the Plains States, which is favorable to a transfer of heated air from lower to higher latitudes in the region where the hot spell developed; and (4) possibly dynamic heating (over Montana) where there was a descent of warm dry air from high to low levels. Just to what degree No. 4 contributed to the rise in temperature over Montana on the 1st and 2d is a matter of speculation, but it seems quite clear that dynamic heating was at least a factor. The pressure distribution, however, is believed to be the controlling and, indeed, the principal factor in the causation of the phenomena.

The cumulative effect of above-normal temperature over the Plains States, especially south of Kansas, for at least two months previous to August 1, must have contributed to the warming of the air layers next to the surface. Kite flights at Drexel, Nebr., directly in the heated area, show that the air up to at least one kilometer above the surface was at a relatively high temperature as late as the 7th, when the crest of the hot weather was over the Atlantic Coast States.

Some idea of the probable magnitude of the changes involved by the transfer of air from one region to another by the circulation induced by cyclonic systems may be had from the excerpt (Table 1) from the Kite Flight, made at Drexel, Nebr., August 5, 1918.

TABLE 1.—*Temperature and wind in the air layers next to the surface at Drexel, Nebr., 10 p. m., Aug. 5, 1918.*

[Courtesy Aerological Division.]

Summer (75th mer.) time. P. M.	Altitude above surface.	Temperature.	Wind.	
			Dir.	Vel. (m. p. s.)
h. m.	*m.*	°*C.*		
10 9	0	33.0	SSW.	9.8.
10 12	104	32.6	SSW.	14.4.
10 13	354	31.8	SSW.	26.0.
10 15	399	31.6	SSW.	28.1.
10 20	604	29.7	SSW.	28.2.
10 25	854	27.5	SSW.	28.3.
Mean		31.0 C.	SSW.	22.4 meters per second.
		87.8 F.		50.1 miles per hour.

An inspection of this table shows that the layers of the atmosphere up to 854 meters (2,802 feet) above the surface were abnormally warm, and that the air was moving from the SSW. at a speed of more than 60 miles an hour in the stratum between 400 and 850 meters above the surface. How are these data to be analyzed? Was there an actual physical transfer of air from one point to another at the speed indicated? If so, the result must be an excess of air in one region and a deficiency in another, a condition that obviously could not exist without making itself visible in the surface pressure distribution.

The pressure distribution on August 1 at the evening observation was characteristic of the hot-weather type for the Plains States and the Mississippi and Missouri Valleys—viz, a trough of low pressure extending from the mouth of the St. Lawrence, west-southwest via the Upper Lakes, the Missouri Valley, the Central Plains States, and the southern Rocky Mountain region, to the summer low in the lower Colorado basin. This trough of low pressure was flanked on its southern side by an area of relatively high pressure, which covered the Southeastern States and the adjacent portion of the North Atlantic Ocean. At no time on the evening maps during the hot spell did the pressure in the southeastern High reach the level of 30.10 inches, although it was always relatively higher than in the northwestern trough. The latter changed from day to day in its minor details, but the essential features were practically unchanged. The method by which it retained its geographic position throughout the 10-day period was somewhat as follows: Pressure over the Canadian Northwest and, indeed, over the Pacific near the coast of Alaska being low, there was no tendency for areas of high pressure to develop in the rear of LOWS. That is to say, there was no reaction to high pressure in the rear of a LOW such as takes place in normal weather conditions. Consequently, along the northern storm path in the United States there was a procession of shallow disturbances, moving slowly and, frequently, in a halting manner, instead of the usual sequence LOW-HIGH-LOW-HIGH, etc.

The southeastern HIGH was a contributing cause, but can scarcely be considered as other than one link in the

[1] See *Brooks, Chas. F.*, Geographical Review. 5: 405-414.
[2] See this REVIEW, February, 1918.

chain of events which produced the hot weather in the great interior valleys and the Plains States.

The pressure distribution on the evening of August 1 (evening maps are considered in all cases) is shown on figure 1 (Chart No. XLVI–72), which is a reduced copy of the weather map for that date. Only the weather maps of the 1st and 8th (8th see fig. 2) have been reproduced, since the intermediate maps are but slight variations on the general type illustrated by the maps of these two dates. Considering now the map of the 1st, it will be noticed that in addition to the general trough of low pressure, there is a cyclonic depression with central pressure 29.65 inches just north of Montana, and that this depression is separated from the trough of low pressure by a shallow HIGH with central pressure of barely 30 inches over Manitoba. In passing, I may say that the only interruption to the procession of LOWS across the Lake region was on the 2d, when this shallow HIGH had moved to the Upper Lake region with an increase of a tenth of an inch in pressure. It caused onshore winds over Wisconsin from both Superior and Michigan, and a temporary cooling of 10 to 15 degrees.

Returning now to a consideration of the LOW north of Montana, it may be remarked that this LOW and its subsequent movement was the immediate circumstance leading to the abnormally high temperatures over the Missouri Valley and districts farther eastward. It is probable that the center of this LOW moved rapidly to the northeast, and that the depression noted over Manitoba on the evening of the 3d was a secondary which formed in its southwest quadrant. In any event, the arrival of this secondary LOW north of Lake Superior on the 4th, and its subsequent drift eastward, was the direct visible cause of the high temperatures in the Lake region on the 4th, 5th, and 6th.

I have prepared temperature charts, of which two are reproduced as figures 3 and 4 (Charts XLVI–74 and XLVI–75), showing the rise and progress of the hot spell. The heavy lines on these charts are lines of zero change in the temperature; the inclosed areas are regions where the temperature at the observation made daily at 7 p. m., 75th Meridian Time, was 10 degrees or more above the normal. Figure 3 (Chart XLVI–74) shows the inception of the hot spell on August 1, with two separate areas of temperature more than 10 degrees above the normal. On the 2d there were still two separate areas, but these had merged into a single area on the 3d, with the peak of the high temperature over eastern Kansas and western Missouri, where the positive departure was 20 to 25 degrees.

The movement of a shallow HIGH across the upper lakes on the 2d, as already mentioned, seemed to intensify the heat over Kansas, southeastern Nebraska, western Missouri, Arkansas, Oklahoma, and extreme northern Texas. Just how this was accomplished is largely a matter of speculation. The apparent effect of this HIGH on the surface pressure distribution was to make a dent in the barometric trough where it crossed the Lake region. In other words, on the evening of the 2d this trough had become crescent-shaped, with low pressure in the two horns of the crescent. The eastern horn hung over the mouth of the St. Lawrence, and the western horn over Missouri and eastern Kansas. The surface wind over the Plains States and the interior valleys was not controlled by this HIGH. Consequently, southerly winds continued and there was no moderation in the temperature due to the presence of the Lake region HIGH. It is clearly apparent that during the 2d and 3d, when the HIGH of August 2 occupied the Upper Lake region, there was practically no eastward advance of the surface heating; but on the 4th, when the HIGH had passed eastward and off to sea over New England, and the secondary LOW, before mentioned, had moved into the Lake Superior region, the trough formation shown in figure 1 (Chart XLVI–72) was restored and there was a decided eastward spread of the high temperatures, the eastern limit at the evening observation of the 4th extending from Erie, Pa., southward into the extreme western part of Virginia.

The high temperature spread eastward more rapidly than the low pressure, a fact which immediately suggests the inquiry, which is cause and which effect? Or are both effects of a common cause?

By the evening of the 5th the eastward limit of the warm weather was found over western New England, with two centers of departure from the normal of 20 degrees or more, one in western Pennsylvania and southeastern Ohio, the other extending from southwestern lower Michigan to northeastern Kansas. A notable feature of the hot weather in the Lake region was the fact that places on the lee shore of the Lake suffered almost as much from the heat as places on the windward side. Thus, Chicago on the windward side experienced a temperature of 26 degrees above the normal on the afternoon of the 5th, while Grand Haven on the opposite or leeward side of the Lake experienced a temperature of 20 degrees above the normal, or only 6 degrees less than on the windward side of the Lake.

The peak of the hot spell was reached in Kansas on the 3d; in Indiana, Ohio, Kentucky, Tennessee, and northern Alabama on the 5th; in the middle Atlantic coast States on the 6th and 7th; and in the Carolinas on the 6th. The hot spell did not extend into Georgia and Florida or into Maine.

The greatest excess of temperature was 26 degrees above the normal at Chicago, Ill., at the evening observation of the 5th. The temperature at the observation was 100°. The temperature was between 20 and 25 degrees above the normal in eastern Kansas and western Missouri on the 3d and 4th. On the 5th the region of greatest departure extended from northeastern Kansas to southern Michigan, and a second area covered the upper Ohio Valley. On this date the temperature was 10 degrees or more above normal over an area of more than a million square miles. On the 6th the high temperatures had overspread the Middle Atlantic States, the greatest positive departures being in Pennsylvania. The hot weather continued in the East over the 7th and 8th, but did not spread into eastern New England.

The hot spell was broken by thundershowers that were irregularly distributed, but were nevertheless effective in reducing the extremely high temperatures, especially in the great eastern cities. A curious anomaly is to be noted however, viz, an interruption of nearly two days in the sequence of thunderstorms in the different parts of the heated territory. On the afternoon of the 4th thunderstorms were fairly general in the upper Lake region and along Lake Erie, and a few isolated storms occurred in the East Gulf and the northern portion of the Middle Atlantic States. Thunderstorm activity was not renewed the next day in the eastern districts, although the LOW, which had become V-shaped with the apex of the V extending southwestward over New England and the Middle Atlantic States, was favorable to thunderstorm development. The next day, the 6th, was equally devoid of thunderstorms except for sporadic cases in the southern Appalachian region. But on the 7th, after the original LOW had passed off to sea, a shallow depression appeared over New England. Almost coincidentally, thunderstorms occurred over the Middle Atlantic States, apparently beginning over the Appalachians of Virginia, West Virginia, and North Carolina, and spreading thence east-northeast. On the following day there

were thunderstorms over a much wider area, principally in the lower Lake region, and although high temperatures still prevailed locally, the strength of the hot spell was broken, and a general lowering of temperatures, beginning in New England, set in and continued for some days. High temperatures continued in western districts until the 14th.

In Washington, D. C., while the atmosphere was extremely hot on the afternoons of the 6th and 7th, the air was dry, and but few serious cases of heat prostration occurred.

The conspicuous features of the hot spell were: (1) Its short duration both in the extreme Northwest and in the East; (2) the general dryness of the air; and, finally, the manner in which it broke up—viz, through local thunderstorms during the night of the 7th–8th.

The duration in the Canadian Northwest and also in Eastern States hardly exceeded two days, although locally in the East there were some high maxima on the 8th.

The dryness of the air was a characteristic feature of the hot weather. In the small table below will be found the mean of the maximum temperatures for the three days on which the highest maxima were registered, and the three-day mean relative humidity for the same days computed from observations made uniformly at noon at each of the points named. The stations have been selected to represent points in a west-east line from Kansas City, Mo., to the Atlantic coast:

Stations.	Mean maximum, 3 days.	Mean noon relative humidity, 3 days.
	°F.	Per cent.
Kansas City, Mo.	106	19
Springfield, Ill.	104	28
Columbus, Ohio	101	41
Philadelphia, Pa.	101	49
Washington, D. C.	103	46
New York, N. Y.	96	45
Hartford, Conn.	94	53

The break-up of the hot spell.—The peak of the hot spell in the East was reached on the 6th, but there were also high maxima on the 7th and 8th. It was not until the 15th, however, that the maximum temperature at Washington failed to register above 85°. After the local thunderstorms on the afternoon of the 7th in the upper Ohio Valley, southwestern Pennsylvania, the northern portion of the Appalachian region, the District of Columbia, and Maryland, the day temperatures did not reach the high figures of the 5th and 6th, but the night temperature of the 8th–9th, in portions of the Middle Atlantic States from Philadelphia, Pa., south, was exceptionally high.

The thunderstorm which occurred at Washington, D. C., on the evening of the 7th was of rather exceptional character. The day was cloudless up to 4 p. m. At 5 minutes after 4 the sun was obscured by a high sheet cloud, probably in the alto-cumulus level. A well-defined type of mammato-cumulus cloud was observed in the north and northwest just prior to the beginning of the thunderstorm. The first thunder was heard at 5:12 p. m. For the next four hours there was a constant display of electrical activity, although rain did not begin until 7:20 p. m. The surface wind which before the storm had been very light from northeast shifted first to southeast and then at 5:35 p. m. to northwest, with a gust velocity of 28 miles per hour, and continued from the northwest, increasing to a maximum velocity of 38 miles at 7:10 p. m. Soon thereafter it diminished in velocity, and by 9:30 p. m. the movement was close to zero. The temperature, which at 5 p. m. was 102°, fell to 73° by 8:30 p. m.

The exceptional character of the storm was the absence of cumulo-nimbus and scud clouds, and the apparent development of the storm at a high level immediately over the District of Columbia. The storm moved to the eastward, and was reported at Baltimore, Md., later in the evening, but did not reach Philadelphia or other stations to the northeast.

On the morning of the 12th high pressure appeared off the coast of British Columbia, and on the 13th and 14th advanced across the northern Rocky Mountain region and the Missouri Valley, thus terminating the period of abnormally high temperature which had prevailed since the 1st.

I have attempted to correlate the movement of the higher currents as indicated by the upper clouds with the weather conditions on the surface.

The proposition has been advanced in some quarters that cirrus clouds moving from east to west are an incident of hot weather in the Plains States. In order to test this proposition I have charted the upper clouds observed not only in the heated area but for all parts of the country for the first decade of August.

On the days when very high temperatures prevailed there was a marked absence of clouds within the heated area, thus indicating that vertical convection was not active. In the few cases of upper clouds observed the movement was closely in accord with the normal expectation, viz, from west to east. The only movement of upper clouds out of the ordinary during the first decade of August was a well-marked advance of cirro-stratus from the southeast, first observed on the middle Gulf coast in the evening of the 5th, continuing on the 6th, and extending inland to Arkansas. Doubtless these high clouds were formed in the outflow from the tropical disturbance that struck the Louisiana coast on the afternoon of the 6th. The movement evidently had no bearing upon the hot weather. A further examination of the upper cloud motion at representative stations in the Middle West for the six months, January to June, 1918, showed especially in March and April a rather large number of westerly motions considering that the normal proportion of westerly to easterly motion is about as 1 to 20. Nevertheless it does not seem probable that the westerly motions observed in March and April can be definitely related to the hot weather experienced in August.

An examination of the record of kite flights at the three aerological stations of the Weather Bureau discloses the following very interesting fact, viz, that on the 5th and 6th, when the lower air strata up to 3 and 4 kilometers were moving from the southwest, as shown by the kites, the upper clouds showed an apparently unbroken movement from the same direction up to the base of the stratosphere. The significance of this movement can not now be discussed, but if it should turn out, as it probably will, that warm southerly winds of great depth are characteristic features of the eastern front of cyclones, and that cold northwest winds are equally a feature of the western side or the rear of cyclonic systems, then it would appear that any hypothesis framed to account for the origin and maintenance of cyclones and anticyclones which does not take account of these two great wind currents is incomplete.

In conclusion, it would seem that the explanation of the abnormally high temperatures of August, 1918, is to be found in the fact that for some time, as a result of the unhindered insolation that had been received at the earth's surface in the Plains States, not only the surface of the earth but the air layers in contact therewith and upward, probably to at least a kilometer above the surface, had become unusually warm; the development of a barometric gradient for fresh southerly winds on the 1st and 2d and again on the 4th, 5th, and 6th, was the concluding step in the phenomenon.

NIGHT-TEMPERATURE STUDIES IN THE ROSWELL FRUIT DISTRICT.

By CLEVE HALLENBECK, Observer.

[Dated: Weather Bureau Office, Roswell, N. Mex., July 23, 1918.]

The region covered by this discussion embraces an irregular area of some 1,200 square miles lying almost entirely west of the Pecos River. Its length, north and south, is about five time its average width, with Roswell within 5 miles of its northern limit, and Carlsbad at its southern limit. (See fig. 1.) This area includes practically all of the fruit-growing and farming districts of the Pecos Valley.

In this region, which is represented by the Roswell Weather Bureau station and six substations, departures of the temperature, on clear nights, from a normal radiational curve are due to five controls or influences:

1. The importation of warmer or colder air.
2. Topographical influences.
3. Air drainage.
4. Mixture of the lower air with the air of higher levels.
5. Local inequalities in the heating and cooling of the ground and lower air.

The dewpoint or humidity factor is omitted, since it is a factor that may be ignored in this district.

When none of these influences is appreciable, which is not often, the night temperature curve is very nearly normal. The term "normal curve," as used herein, refers to a night temperature trace due only to radiational cooling. It is apparent that this may vary on different nights, or in different localities. A normal cloudy night radiational curve would, in this district, have less than half the range of a clear-night curve; the range of temperature over cultivated and irrigated country likewise would be less than over the dry, bare prairie, although in each case the thermograph trace may be approximately a normal radiational curve.

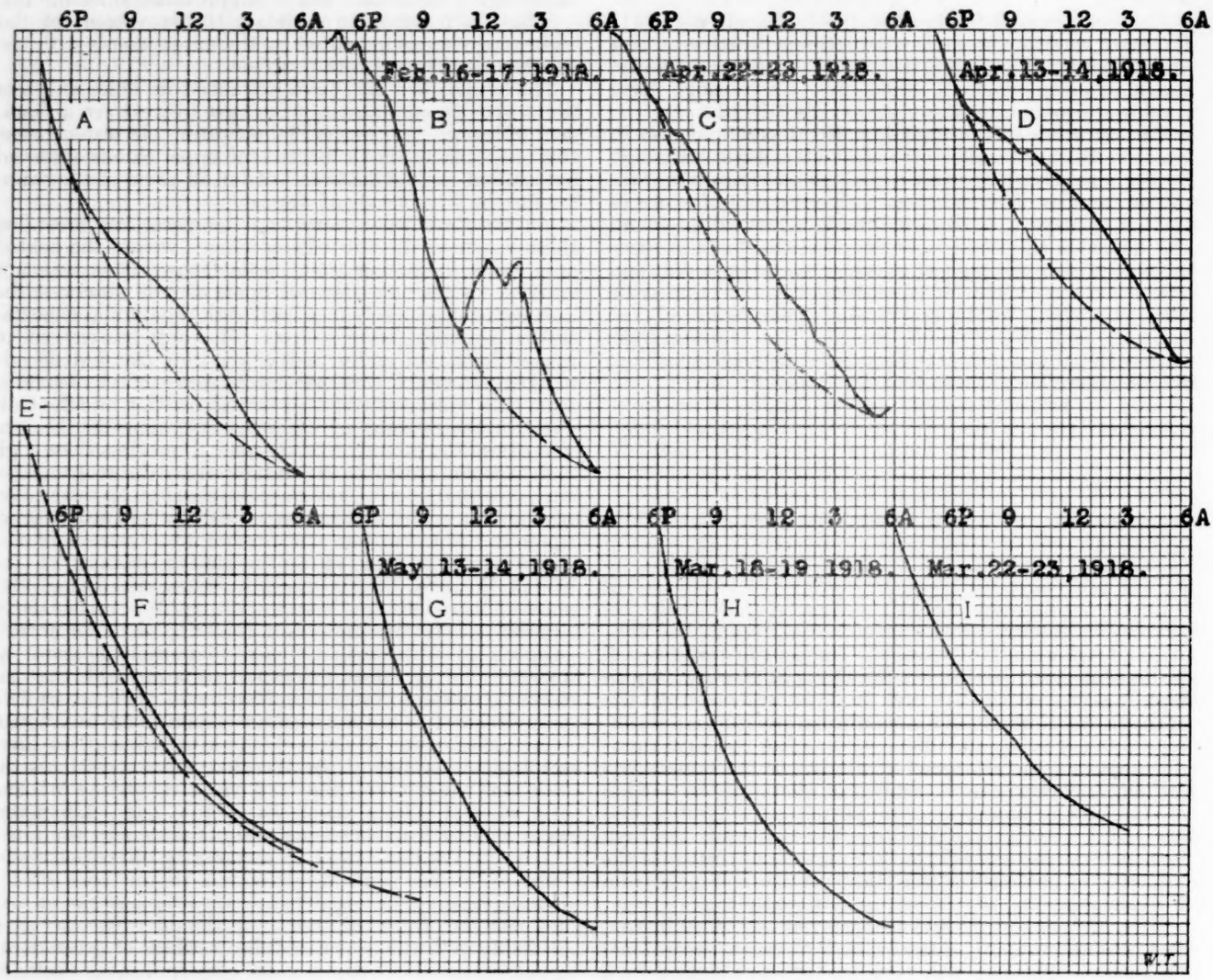


FIG. 2. A, average radiational night trace for spring of 1918. B, C, and D, individual night traces. E, a parabolic curve. F, average of all normal night traces for spring of 1918. G, H, and I, individual approximately normal night traces.

The term "normal position," also used herein with reference to night temperatures, requires definition. The normal position of the temperature at any hour of any night is the point at which that hour line on the thermogram is intersected by the normal temperature curve for that night, which itself can be constructed from the completed trace by eliminating from the trace all controls other than radiation. It can also be approximately de-

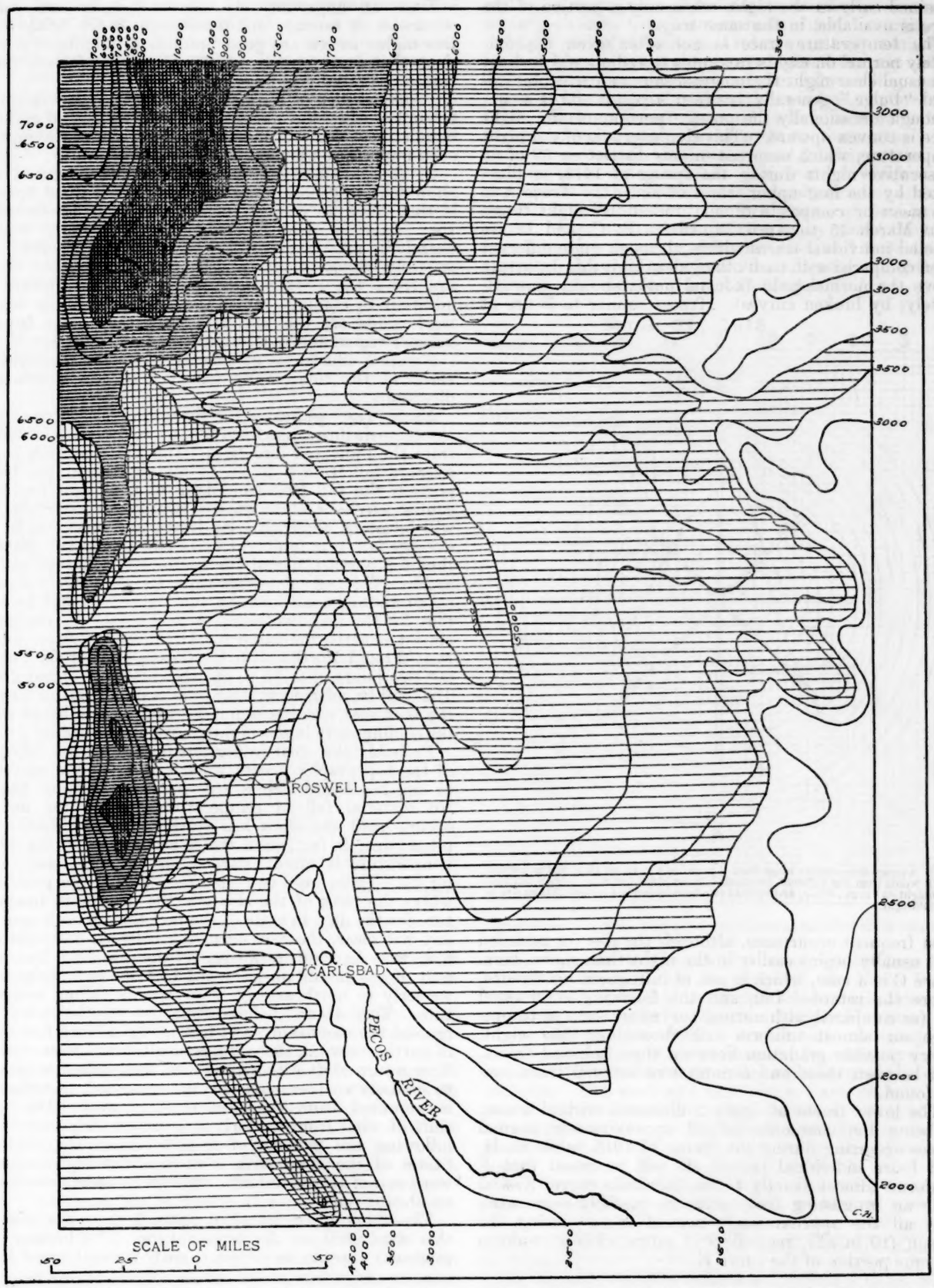


FIG. 1. Topographical map of Pecos Valley in New Mexico. Contours drawn for every 500 feet vertical elevation up to 8,000 feet, and for every 1,000 feet from 8,000 to 10,000.

termined early in the night, when only a portion of the trace is available, in the same way.

The temperature trace is not often even approximately normal on nights favorable to radiational cooling. The usual clear-night thermogram shows an irregular upward "bulge," generally between 9 p. m. and 3 a. m., although occasionally the greater portion of the night trace is convex upward. This characteristic of the night temperature, which occurred in this district on 59 of 95 consecutive nights during the spring of 1918, is illustrated by the four upper traces of figure 2. Trace A is the mean or composite of all "radiation" night traces from March 15 to April 30, 1918. B, C, and D are selected individual traces which, although quite different when compared with each other, all exhibit this departure above the normal path (normal paths shown, approximately, by broken curves). Traces similar to B are of

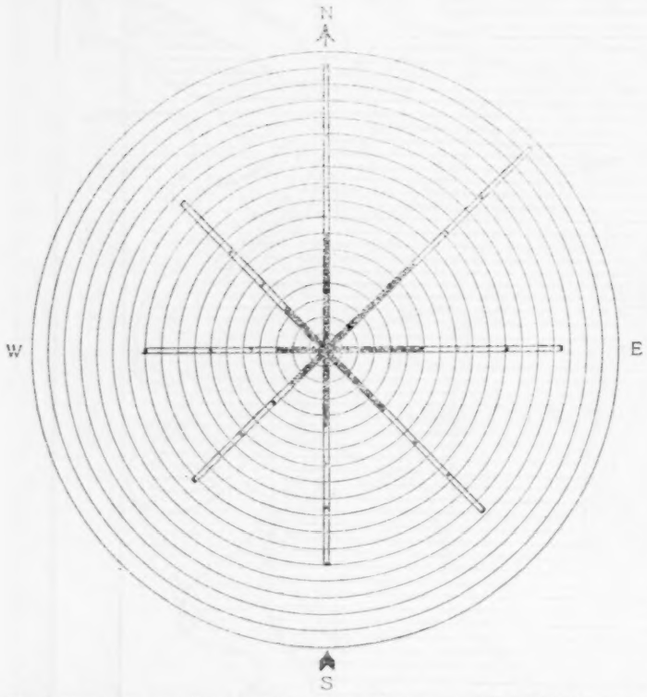


FIG. 3. Average temperature range from 6 p. m. to 6 a. m. on clear nights in spring with winds from the different directions. Solid black indicates average fall from midnight to 6 a. m., white, divided into two-hour intervals, average fall from 6 p. m. to midnight.

most frequent occurrence, although the rise (or retarded fall) usually begins earlier in the night than shown here. Trace C is a case, which is not of infrequent occurrence, where the retarded fall, and the following accelerated fall (as compared with normal curve) are such as to produce an almost uniform fall throughout the night. Every possible gradation between these selected traces, and between these and a normal radiational trace, can be found.

The lower traces of figure 2 illustrate normal traces, F being the composite of all approximately normal traces occurring during the spring of 1918, while G, H, and I are individual traces. It will be noted that F conforms almost exactly to the parabolic curve, E, and it is an interesting fact, although possibly accidental, that all the approximately normal traces during the season (10 in all), regardless of range, closely conform to some portion of the curve E.

Since an approximately normal temperature curve occurs on an average on but one night in ten, while fully five nights in ten are good "radiation" nights, it is evident that one or more of the disturbing factors mentioned are usually to be expected.

1. *Importation of warmer or colder air.*—This refers to the inflow of cold or warm air in anticyclonic and cyclonic circulations, and will not be further discussed except as such importation is modified by the topography.

2. *Topographical influences.*—Reference to figure 1 will show that, in general, winds in this district trend upward if they have an easterly component, and downward if they have a westerly component. Easterly winds, therefore, are more or less dynamically cooled, and westerly winds similarly warmed. The coldest winds are from the northeast, trending slightly upward in addition to coming from a cooler region, while southwest winds are the warmest, since they come from a warmer region and in addition trend downward.

Figure 3 illustrates graphically the wind-temperature effect of the topography for each of the 8 principal directions.

Each "ray" indicates for the spring season the average temperature range from 6 p. m. to 6 a. m. with winds from the indicated direction. The white portion is the average fall from 6 p. m. to midnight, and the black portion the fall from midnight to 6 a. m. The concentric circles are drawn for two-degree intervals. It will be noted that with southwest and west winds the average fall from midnight to 6 a. m. is only two-fifths of that for northeast, and for northwest is hardly half as much. The fall of temperature by two-hour intervals up to midnight is shown on this figure. It will be seen that for the first two hours, 6 to 8 p. m., the cooling is almost exactly the same for all directions from southwest through northwest to northeast, and for the following two hours, 8 to 10 p. m., the difference is not great. This will be referred to later, and is important in view of the fact that evening temperature forecasts based upon the cooling early in the night are usually issued by 8 p. m.

Probably the most important feature of the influence of the topography occurs when a HIGH moves eastward or southeastward across the central mountain States. No material fall of temperature beyond the normal occurs until the HIGH has spread eastward across the mountains; in fact, until this is accomplished, the fall of temperature is often retarded, or actually rises. (See fig. 4). There were two such rises during the year 1916 where the peak of the rise was the maximum temperature for the day, in spite of the fact that in each case the day was clear, the rises occurring between midnight and 6 a. m. As soon, however, as the pressure has risen east of the mountains, the wind at Roswell shifts from westerly to northeasterly, with rapidly falling temperature. This occurs before the crest of the HIGH has crossed the mountains, and frequently, after a few hours of northeast wind, there is a return to northwest or west. This return shift often gives the impression, when the twice-daily weather maps only are consulted, that the cold is imported from the west or northwest. The same shift of wind from westerly to northeasterly may occur following the passage of a LOW across the southern States of the West with a HIGH advancing southeastward *east* of the mountains, and it is in nearly every case an abrupt shift.

The three upper traces of figure 5 show the effect of this wind shift on the temperature. The broken lines represent the rise in pressure, each vertical space being

equal to 0.02 inch on the mercurial barometer. The three lower traces were made with similar rises in pressure, but with the wind remaining westerly or northwesterly throughout the night. It may be of interest to note that trace F, made on the second night after trace C, reached a minimum of only 49°, while the minimum of trace C was 11 degrees lower, or 38°. The wind direction attending trace C (at top of figure) shows the return of the wind to westerly after having blown from the northeast for five hours. The wind was southwest at 6 p. m., and west at 6 a. m.; therefore it would appear from the weather maps that the unusual fall of 43 degrees had occurred with a westerly wind.

These are cases of importation of cold air controlled or modified by the topography. Such cases as those shown by traces A, B, and C, figure 5, occur, on an average, nights in spring, usually shifts to northerly or northeasterly at some time between midnight and sunrise, and in 91 per cent of the instances it has a westerly component for 2 or 3 hours before the change to northeasterly occurs. This results in a retardation of the night cooling during those hours, especially when the wind is moderate to brisk. The northeasterly wind, which is always light except when supported by a HIGH to the north, is apparently a case of air drainage and is characteristic of clear nights in spring and fall. This current, which occurs in all parts of this district and probably to some distance beyond in each direction, is probably never of considerable depth. Low stratus clouds have many times been observed moving in an opposite direction, and several early morning observations of smoke indicated a depth, at Roswell, of between 220 and 250 feet.

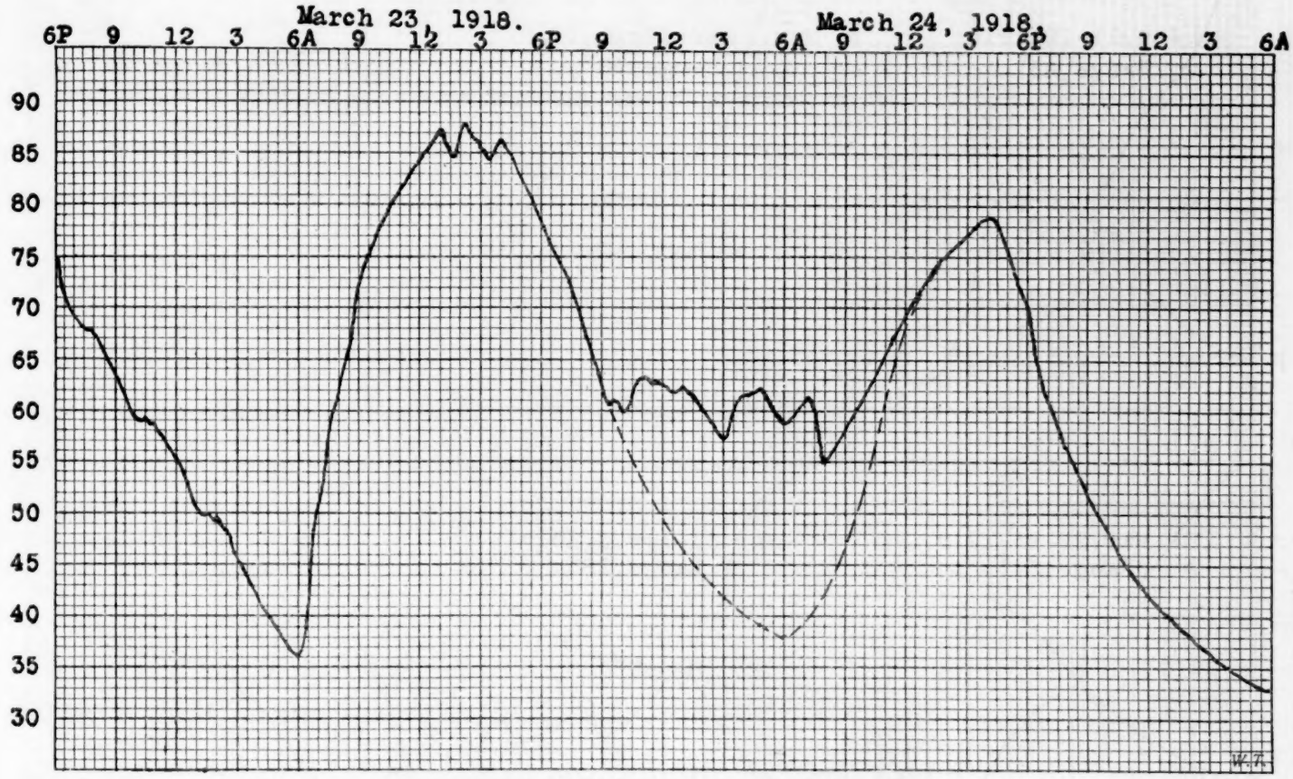


FIG. 4. Effect of continuing westerly wind in preventing the normal radiational cooling on night of March 23-24, 1918. Broken line shows curve as calculated the evening before.

twice during the critical season in spring, and as a result damaging temperatures occur on an average once each season.

3. *Air drainage.*—In the absence of controls other than radiation and solar heating, the wind at Roswell evidently would shift from south through west to north during the first half of the night, and back to south through east during the forenoon. A comparatively slight barometric gradient will modify the normal shift, which in an ideal form is not frequently observed. The tendency, however, is clearly revealed in the hourly frequency of the wind from the different directions over a period of a month or more. The maximum frequency of the wind from the different directions is as follows: North, 3–4 a. m.; northeast, 6–7 a. m.; east, 7–8 a. m.; southeast, 12–1 p. m.; south, 2–3 p. m.; southwest, 9–11 p. m.; west, 11–12 p. m.; northwest, 2–3 a. m. Even when the entire circuit is not made, the wind, on clear

An objection to the postulation of air drainage may appear in the fact that the trend of the Pecos Valley through this district is north and south, while this wind is more northeasterly than northerly. However, the Pecos Valley in New Mexico is such as to encourage the development of night air drainage.[1] Its southward slope is about 10 to 12 feet per mile, and the grade is quite uniform. The west and east slopes have each a horizontal width of some 60 miles; eastward, however, the maximum elevation is only about 1,500 feet above the elevation of Roswell, while westward, in an equal horizontal distance, the land rises 4,000 to 5,000 feet above the elevation of this station. The valley floor contains no elevations or depressions worthy of mention.

[1] "Air drainage" is here used in the sense of a slow, steady flow down a gentle slope, where the cooling of the air by conduction and by radiation is sufficient to offset the adiabatic heating of the air in its slow descent. There is no question but that air drainage as usually thought of, i. e., a continuous flow of air down a slope, can occur under such conditions. See Bulletin of the Mount Weather Observatory, vol. 6, pp. 123-124.—W. R. G.

The tributaries of the Pecos are insignificant and follow shallow depressions; in some cases the streams have no valleys at all, being nothing more than arroyos. Some idea of the smoothness of the valley floor may be gained from the fact that the orchards and masses of shade trees in this district offer greater obstruction to the flow of air than do any features of the valley landscape.

It will be noted that Roswell is located some 8 miles west of the Pecos River (see fig. 1), and where the maximum slope of the land is to the southeast; so that a northeasterly wind is blowing nearly at right angles to the direction of greatest slope.

the time of minimum temperature, which is further illustrated by traces E to H. On the first three of these four dates (E to H) the minimum occurred one and a half hours after sunrise, and on the fourth the minimum was not reached until about three hours after sunrise. Clear skies prevailed on each of the four mornings. On the first three the observer would have been justified in assuming at sunrise that the minimum had been reached, since the temperature in each case was rising at the time. On the fourth date the minimum apparently was reached at 6 a. m., and for an hour thereafter the temperature rose. The sun was then 1 hour 45 minutes high, and the

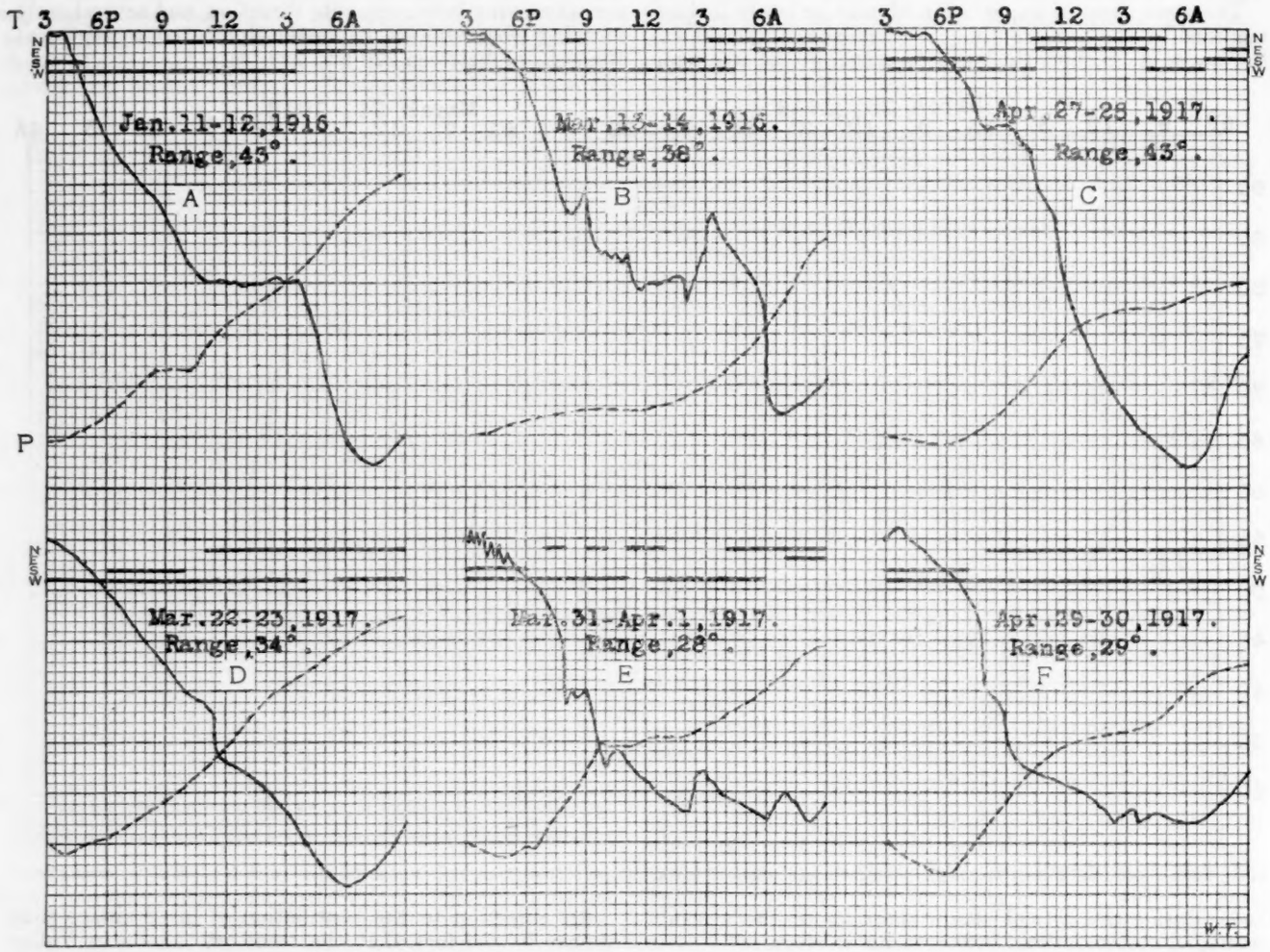


FIG. 5. Modification of importation of cold air, by topography. Upper traces: Temperature fall attending shift of wind from westerly to northeast with rising pressure. Wind direction at top of trace; broken line represents pressure rise. Lower traces: Similar pressure rises, with wind remaining westerly.

Since the wind prior to the shift to northeasterly nearly always has a westerly component, the fall of temperature is retarded before the shift, with an accelerated fall after. It is possible that this is not entirely a topographic influence, since the same condition often obtains with a steady wind from some one direction. The writer has never noted a case of retarded fall with north, northeast, or east winds, or of an accelerated fall with west winds.

In figure 6 are four sets of thermograph traces illustrating the effect of air drainage. The first set (A to D) shows the temperature fall resulting from shifts to northeast at (A) 2 a. m., (B) 3 a. m., (C) 4 a. m., and (D) 5 a. m. Trace D also shows the effect of a late shift in advancing

following unexpected fall of temperature, amounting to 10 degrees, could have been due only to an influx of cold air. This fall attended a shift of the wind from northwest to northeast.

Traces I to L, inclusive, are examples of what local orchardists call the "dip" in the temperature, and are really sharp falls due to late shifts of the wind to northeasterly, occurring usually after daybreak and sometimes after sunrise. These sharp and unexpected falls are one of the chief concerns of the fruit growers in this district. Several orchardists, according to their own information, have suffered serious loss in past seasons from morning "dips" that, occurring after the minimum was believed

to have been reached, took them unawares and damaged the fruit before additional heaters could be brought into action.

On an average, five such "dips" occur each spring (Mar. 15 to Apr. 30), two of which reach injurious temperatures. Injurious temperatures occurring half an hour or more after sunrise (clear weather dates only being considered) occur, on an average, twice each spring.

It is the practice of a number of experienced orchardists to hold their orchard temperatures several degrees

Traces M to P of figure 6 illustrate the effect of continued westerly winds during the night. Up to midnight these traces are not noticeably different from those with morning-air drainage, since up to midnight the wind in each case is westerly or with a west component.

Some idea of the frequency of air drainage may be obtained from the following: In March, 1918, there were 15 "radiation" nights, on 14 of which air drainage occurred. In April there were 15 radiation nights, 11 of which had a period of air drainage. In May, with 13

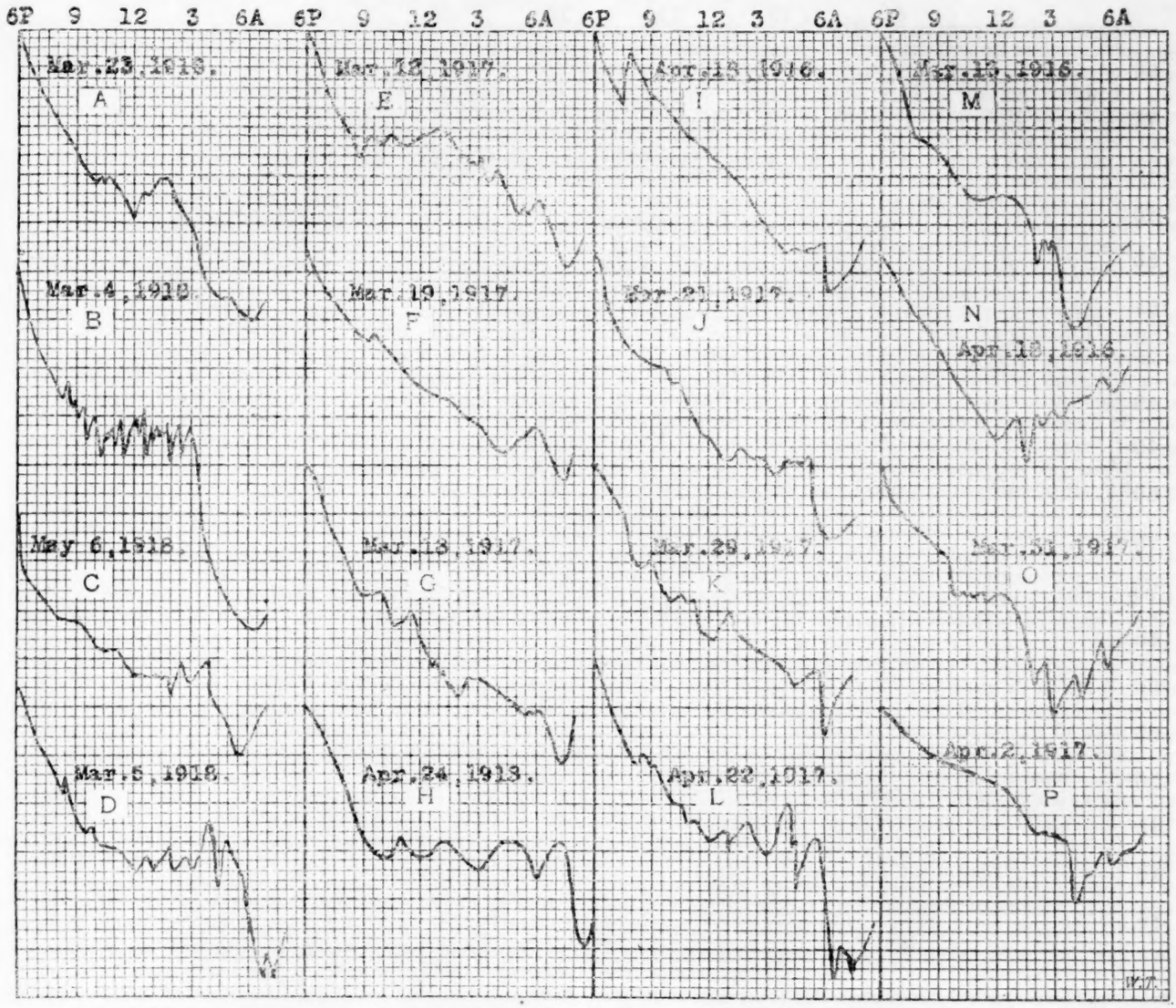


FIG. 6. A to D: Temperature falls due to air drainage. E to H: Illustrating effect of late air drainage in advancing time of minimum temperature. I to L: Sharp falls in temperature, occurring after daylight (I and L, after sunrise), due to late shifts of the wind to northeast. M to P: Effect of continued westerly winds through the night.

above the critical point, so as to minimize the injurious effect of any sudden or unexpected inflow of cold air. The wind is usually very light at the time, and the change in direction, occurring without any change in velocity, may often pass unnoticed.

It should be stated here that the sharp falls such as have been discussed occur only with shifts of the wind to northeasterly; that is, to any direction between north and east. Accelerated falls may attend winds from other directions, but nothing of the nature of a sudden fall.

radiation nights, air drainage occurred on 6. It will be noted that the relative frequency of this condition decreases as the season advances.

4. *Mixing of air strata of different temperatures.*—Spring being normally the driest season of the year in this district, the daily range of temperature also is normally greatest during this season. In country exposures nights with 40 to 50 degrees radiational cooling are the rule, and the temperature frequently falls as much as 30 degrees between sunset and midnight. Outside the farming dis-

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tricts the range of temperature must be still greater. This rapid cooling during the night, following the equally great heating during the day, is very favorable to the establishment of pronounced vertical temperature inversions, and the mixing of the cool lower stratum with the air of higher levels would result in temperature fluctuations of considerable amplitude. Such disturbances of the temperature would be expected to occur with a change in the wind direction or with an increase in the velocity, and it is attending such changes that the temperature fluctuations most commonly occur. They also are more frequent and of greater amplitude after midnight than before, and during periods of dry weather than when the ground is moist.

5. *Unequal heating of the ground and lower air stratum.*—The irrigated and cultivated portions of the Pecos Valley are not contiguous. Large areas, comprising from less than a square mile up to 40 to 50 square miles, under irrigation and cultivation and covered with vegetation often luxuriant, are interspersed with almost equal areas of dry, bare prairie land, while surrounding the whole is a vast stretch of arid or semiarid country.

The relative amounts of heating and cooling must be quite different for the different areas. The writer has often noticed the change in temperature experienced in passing from a region of arid prairie land to an irrigated region covered with growing crops. The writer also once experienced, while traveling along a level country road in the early morning, three distinct alternations of warm and cool air; the difference in temperature was not only noticeable but remarkable, probably amounting to as much as 10 degrees.

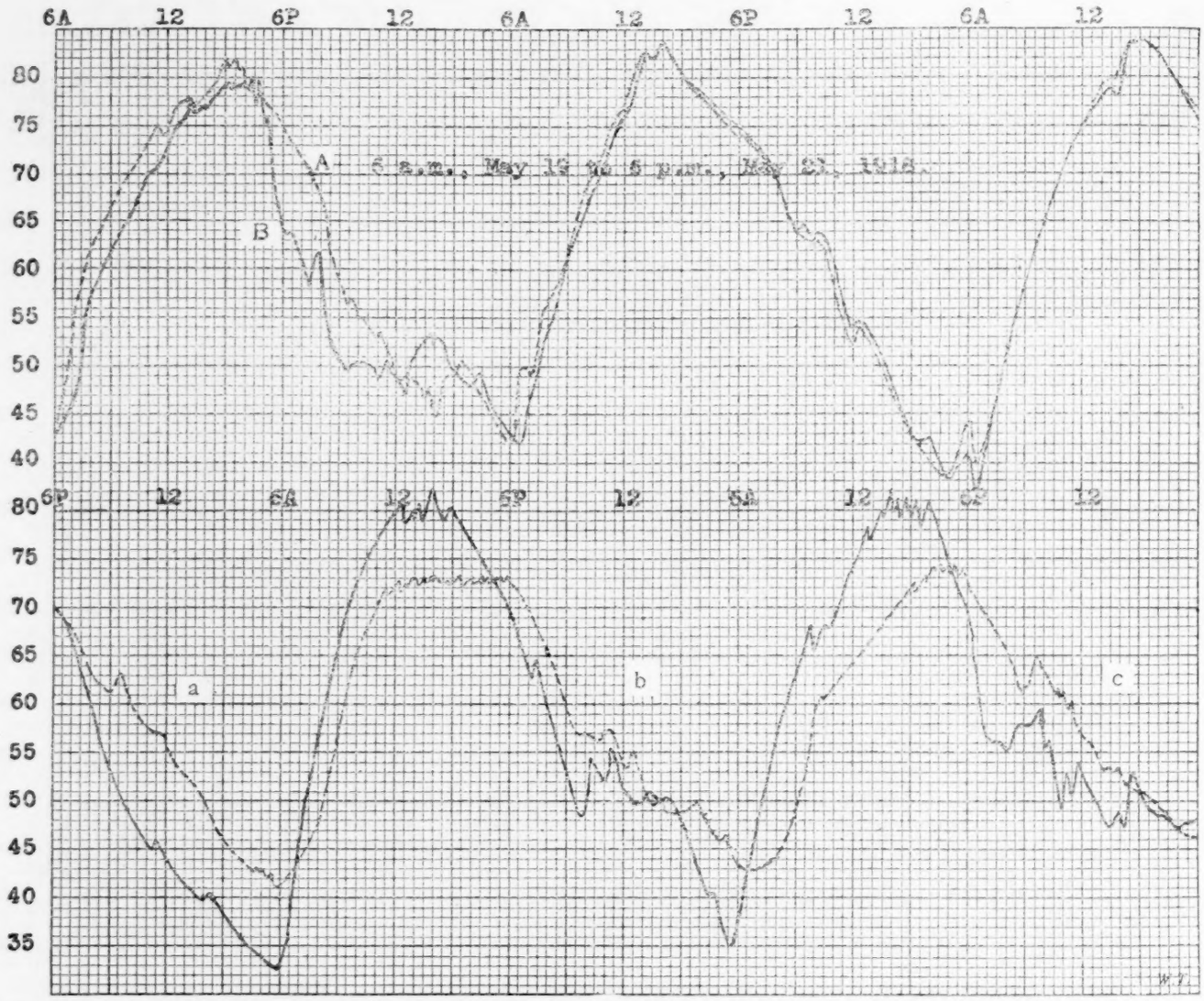

FIG. 7. Upper traces: Effect of local inequalities in night cooling (night of May 19–20). Lower traces: Comparison of rural temperatures (solid line) with city temperatures (broken line), and showing (*a*) a night with approximately normal cooling, (*b*) a night with air drainage after 2 a. m., and (*c*) a night with retarded cooling after 7 p. m.

Such conditions may produce temperature fluctuations both day and night, especially when the wind is variable. In the farming districts these probably are rises during the day and up to the median temperature hour and falls thereafter.

An example of what the writer believes to be temperature variations of this type is shown by the upper traces of figure 7 (May 19). The two superimposed traces were made at two substations less than 3 miles apart, whose exposures and general surroundings were as nearly alike as was practicable. As a rule the thermograph traces of

these two stations are nearly identical, as shown by the traces for the following two days (May 20 and 21). On the date in question the night traces were so dissimilar that it would appear they were made at stations far apart or under widely different conditions of exposure.

The lower traces of figure 7 are a comparison between thermograph records made at the Weather Bureau station, under city influences (broken line), and at the substation at the writer's residence, under entirely rural surroundings (solid line). Besides showing the effect of city influences, these show the differences between the two records on (*a*) a normal radiation night, (*b*) a night with air drainage, and (*c*) a night with retarded cooling after 7 p. m.

It has been mentioned that the retarded cooling during the first half of the night, followed by an accelerated fall of temperature, is often observed with other conditions of wind direction than westerly wind shifting to northeasterly. This may have a possible explanation in the fact that the range of temperature in the farming region must be less than the range over the bare prairie. The daytime heating and the night cooling would each be less in the cultivated and irrigated region. Winds from off the prairie would, therefore, tend to retard the cooling until they were themselves cooled radiationally to the same temperature, after which, being cooler than the air over the farming country, they would tend to accelerate the fall of temperature. In such cases, however, the temperature evidently should begin to fall at a rate greater than normal at about 8 p. m. (the median temperature hour) instead of at midnight or after, as observed. The fact that the thermographs are located some distance from the open prairie, in the interior of the farming country, may explain this discrepancy.

The small but abrupt drop in temperature that accompanies the arrival of an early morning northeast wind is without question due to unequal cooling. This air is from off the exceptionally bare prairie land to the north and northeast, and, being cooled radiationally to a temperature several degrees below that of the farming district, naturally flows down valley through that district.

Forecasting.—It is evident from the foregoing that the wind direction is an important factor to be considered in forecasting night and minimum temperatures. On occasions it may be the only factor, in addition to the normal radiational cooling.

On nights when the wind direction will be controlled by pressure gradients, the topographic factor has to be considered. Normal falls of temperature usually occur with south and southeast winds, as the mechanical cooling about neutralizes the excess warmth.

On clear nights, the fall of temperature up to 8 or 9 p. m. is about the same for all directions of wind having a westerly or northerly component, and therefore the cooling in the early evening may be no guide as to what the subsequent fall of temperature is likely to be. Even when the pressure is rising with a northwest wind, the cooling during the early hours of the night may not be more than normal, and may even be less than normal.

This condition, where a HIGH is developing across the central mountain States, presents a situation that requires careful attention. The time at which the wind will shift from northwest to northeast often determines whether or not injurious temperatures will be reached. This may occur at any hour of the day or night, although its time of maximum frequency is about sunset, with a secondary maximum near midnight. But even if it occurs as late in the night as 3 a. m., in the spring it is likely to reduce the temperature to a critical degree by sunrise. The examples that are submitted in figure 5 are not extreme cases. The following is an example of an extreme case that came under the writer's personal observation: On October 28, 1917, a sudden shift of the wind from west to northeast resulted in a fall of temperature of 27 degrees in one hour and 45 degrees in five hours. In two hours the temperature was reduced from 68° to freezing; and since this occurred at night, a great deal of picked, exposed fruit was frozen before it could be sheltered or protected.

That such a shift will occur can usually be successfully forecast from the weather and pressure-change maps, and the time within three hours can often be forecast also. Further than this it is impossible to go. It is of some value, however, to have the fruit growers advised of the impending change, so that they can prepare in advance. Where the local conditions announce a freeze 12 to 24 hours in advance the orchardist needs no further notice; but in the case of the sudden falls of temperature here described, the fall is nearly always preceded by temperature above normal, and sometimes, as mentioned before, there is a decided rise for two to four hours preceding the shift of the wind.

On clear, still nights in spring a period of air drainage is usually to be expected; but since the retarded cooling, which normally occurs before midnight, is in most cases compensated for by the following rapid cooling, the median hour temperature method of calculating minimum temperatures can be employed with a fair degree of success. Where the cooling is noticeably retarded before the median hour, the probable range for the night can be approximated by applying a correction to the median hour temperature.

The late, sharp falls in temperature, such as are shown in figure 6, present a slightly different problem. As a rule it is impossible to forecast on the preceding day even the approximate time when the northeast wind will set in. "Dips" in the temperature, therefore, can not be forecast much in advance. Before the shift, however, the wind velocity decreases for two to four hours from an average of about 6 miles per hour to about 2 miles or less; sometimes it is almost calm for half an hour before the shift occurs. This condition enables the forecaster to give the orchardists precautionary advices an hour or more in advance. It is the writer's experience that on critical nights the observer is kept up all night, so that the issuing of a precautionary warning at 3 or 4 a. m. is no inconvenience.

At such times the fact that the normal minimum will very probably be reached is an aid to the forecaster in estimating the amount of the early morning fall of temperature. The only danger is that the normal fall may be exceeded, as sometimes is the case when late shifts of the wind occur.

Variations in the temperature, due to the mixture of air strata of different temperatures, or to inequalities in the cooling of the lower stratum, may occur early in the night, so that the temperature at the median hour may not be the true median temperature. Such variations are easier to detect from an examination of the thermograph trace than is a gradually retarded fall. In both cases it is necessary to correct the median hour temperature, or the temperature at 8 p. m. in case the cooling from 6 p. m. to 8 p. m. is used, in estimating the probable minimum.

It was stated on page 364 that the normal cooling for any night can be determined at an early hour—say at 8 p. m.—if the accidental variations occurring up to that

hour can be eliminated. And since on clear, still nights the range is, with certain exceptions, very nearly the same as would have occurred with normal cooling, it follows that the actual range can be very nearly calculated.

The writer takes into account the following in eliminating the accidental variations from the thermograph trace when such occur before 8 p. m.: (1) The character of the trace before the irregular variations began; (2) observations of the wind direction for two hours or more before 8 p. m.; (3) the range of temperature on previous similar nights; (4) the character of the temperature variations.

If the night promises to be favorable to radiational cooling, then the range of temperature on previous similar nights is of value. Minimum temperatures calculated by this means alone will be within 3 degrees of the actual minimum about half the time.

Frequently the normal cooling up to the hour of observation (8 p. m.) can be closely approximated by projecting the portion of the thermograph curve made before disturbing influences set in downward along a normal path; the point on this projected curve at the median hour is the normal position of the median temperature.

The character of the temperature variations is sometimes of considerable aid in plotting the normal curve. Any disturbances of the temperature at or near the hour of observation on "radiation" nights are nearly always rises. Such disturbances are often in the form of a number of rises and falls, and the lowest points reached are usually on or very close to the normal radiational path, as in trace C, figure 8.

Observations of the wind direction are also of value in determining the character of the night trace.

The three upper traces of figure 8 illustrate the method used in correcting the median hour temperature. Trace A was made at the New Mexico Military Institute, where the median temperature hour for April is 7:50 p. m., and B and C were made at the writer's residence, where the median hour for February is 7:35 p. m. The calculated normal curve for each night, up to 8:30 p. m., is shown by the broken lines. The asterisks at 6 a. m. mark the calculated minimum temperatures, while the small circles mark the minimum temperatures that would have been calculated by using the actual median hour temperature. Traces D, E, and F are examples of temperature fluctuations that did not begin until after the median temperature hour. Here the usual median hour temperature method may be applied with satisfactory results.

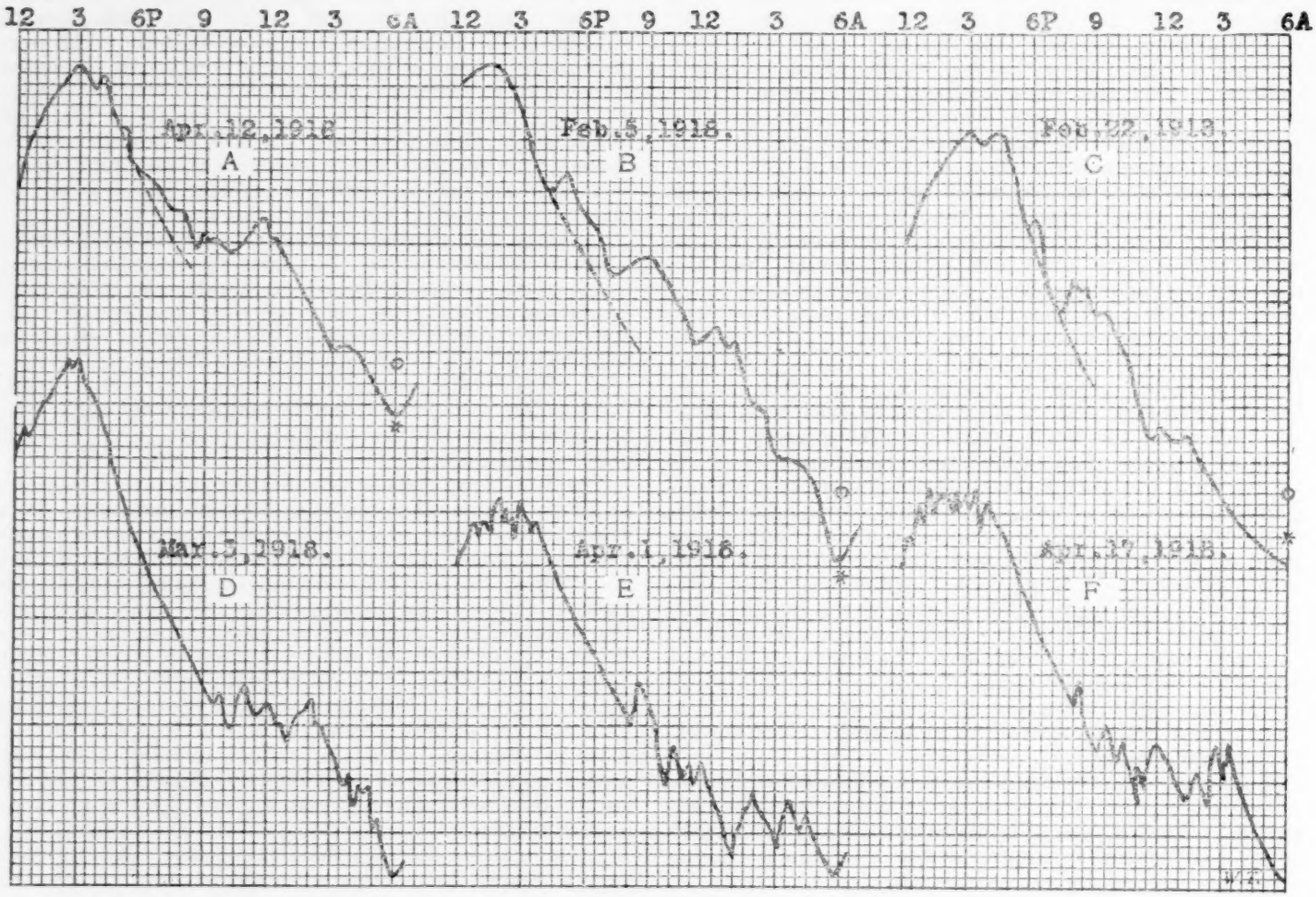

FIG. 8. Application of "corrected" median hour temperature method. On upper traces, broken line shows calculated normal curve up to 8.30 p. m. Lower traces: Cases where temperature fluctuations were not apparent at the time of median temperature.

In determining to what extent, if any, the fall of temperature early in the night is being affected by the importation of warmer or colder air, the character of the temperature curve during the day, and the time of maximum temperature, are considered. An inflow of cold air sufficient to reduce the temperature 1° per hour will cause the maximum to occur about one hour earlier than normal, provided this cooling influence has been active throughout the day. With clear weather, a slight im-

portation of cold or warm air can also often be detected by comparing the noon temperature with the temperature at 6 p. m. The difference between these two temperatures varies with the season, but in April, in rural exposures in this district, the temperature at 6 p. m. is normally 7 degrees lower than at noon. If, for example, the temperature at 6 p. m. is 10 degrees lower than at noon, it is assumed that during the 6 hours there has been an inflow of cold air sufficient to reduce the temperature 0.5 degree per hour. Whether such cooling was active throughout the six hours can often be determined from the thermograph trace. The use of these methods presupposes that the cooling or warming will continue throughout the night, which is not always the case. Where the reception of solar radiation is materially interfered with by cloudiness during the afternoon the method has no value.

The condition of the ground as regards moisture is also a factor to be considered. A rain will materially lessen the range of temperature for the following night, and probably for several nights, depending on the amount of moisture retained by the ground. It will also reduce the irregular variations in both number and amplitude.

The dewpoint is so infrequently reached that the forecaster can usually afford to ignore it. In the spring the average difference between the minimum temperature and the morning dewpoint is 18 degrees.

It was stated in a preceding paragraph that there are exceptions to the rule that the normal minimum will be very nearly reached on nights favorable to radiational cooling. One of these exceptions is where the wind, which is normally westerly during the first half of the night, continues from the same general direction throughout the night. This is due, of course, to an increasing pressure gradient from east to west across New Mexico, but it is often difficult to know whether or not such gradient will be sufficient to control the wind direction during the second half of the night. It may develop during the night, when such development can not be foreseen on the preceding day. This is likely to modify greatly the course of the temperature after midnight, and minimum temperature forecasts on such occasions may be as much as 10 or 12 degrees in error. A single example of this is presented in figure 4, for the night of March 23–24, 1918. The broken line here represents the normal cooling, as calculated at 9 p. m. the evening before. Also, with westerly winds, the minimum temperature is likely to occur at any time between midnight and morning. In figure 6, traces M to P, the minimum of each trace was due to a temporary shift of the wind to east or northeast.

The second exception to the rule is where a late shift of the wind to northeast occurs. Traces B, D, J, K, and L, of figure 6, may serve as illustrations.

Temperature irregularities due to the mixing of the lower and upper air or to the unequal cooling of the lower air do not materially affect the minimum, except in the case where such a fluctuation occurs at the time of minimum temperature. This unequal cooling is normally most pronounced early in the morning, and the temperature variations due thereto may be considerable, but as a rule they are not of sufficient amplitude to destroy the value of the forecast.

Most of the local orchardists who practice orchard heating are equipped to meet successfully any low temperature that is likely to occur. Consequently they are as much interested in knowing at what hour of the night the temperature will reach a critical degree as in knowing what the minimum is likely to be. Owing to the usual extreme irregularity of the night thermograph trace on nights favorable to radiational cooling, it is easier to calculate the temperature for different hours of the night when there is a decided inflow of cold air. In spring, however, the temperature rarely reaches a critical point before 4 a. m., and the temperature at this hour can be calculated with a greater degree of accuracy than for any preceding hour back to midnight. This is because, as has been stated, the temperature on "radiation" nights tends to regain its normal path in the early morning hours.

ICE STORMS IN THE SOUTHERN APPALACHIANS.

VERNE RHOADES, Forest Examiner in Charge Pisgah Purchase Area.

Numerous brief records have been made from time to time relating to the severity of ice storms in various sections of the United States. So far as the writer is acquainted with the accounts of such atmospheric disturbances published in this country, none of them speaks of damage to tree growth as being as widespread or so injurious in their effects as that which was occasioned by an ice storm which passed over the hardwood region of a portion of western North Carolina and northwestern South Carolina in the early spring of 1915.

A rain began falling at 6 p. m. on March 4, 1915, and about midnight the temperature dropped to freezing. The rain thereupon turned to sleet, and for the ensuing 24 hours, from midnight on the 4th to midnight on the 5th, the precipitation was practically continuous either as rain or as sleet. A heavy coating of ice encased the branches, both large and small, of all trees found within the compass of the storm, which followed a general southwesterly direction in the vicinity of Hendersonville, Saluda, and Tryon, N. C.

At the higher elevations in the mountains—in Pisgah Forest, for example—the greatest amount of damage to tree growth was on the slopes facing the south and east. In the valleys the severity of the storm was felt alike on the hills and along the streams.

On the following morning the chestnut and oak slopes showed a vast array of whitened, splintered tops and trunks where the limbs had been torn away. It was a striking, though not a pleasing, picture. It was an easy matter for one to stand in one spot and count hundreds of trees which had lost a portion or all of their tops and branches because of the weight of the accumulated ice. In the heads of some of the coves in Pisgah Forest the ice on the ground was 20 inches or more in depth where it had fallen from the trees. In numerous instances white oak, chestnut oak, and red oak with their strong fibers were broken off sheer at a height of 20 feet from the ground. One 16-inch white oak was observed in a small opening in the surrounding forest with its trunk snapped in two. No defect contributed to its fall. The number of trees in the region which plainly showed the marks of the ice storm must have totaled in the hundreds of thousands.

Apparently no one species withstood the shock of the ice better than another. This observation applies particularly to the mixture of the species where the ice deposit was the heaviest. Probably more chestnut trees were injured than any other species. This was due probably to the fact that chestnut is numerically the leading species in the region rather than to any brittle quality of its wood. Young trees with flexible branches suffered as severely as did old trees of stiffened fiber.

Oaks of all species, chestnut, basswood, yellow poplar, white pine, yellow pine, and even hickory were hard hit. Second-growth yellow poplar coming up in dense stands

in certain localities had 90 per cent of their number injured beyond recovery. Similarly in the case of chestnut, particularly chestnut coppice sprouts. Oaks were stripped of their branches. Yellow poplars of pole and standard size frequently broke squarely off below their crowns. Hickory was bent far over with interlocking limbs. Trees with twining vines were broken in two or borne down past recovery.

Had there been a heavy wind immediately following the storm the damage resulting would have been little short of disastrous. It is possible that where certain species, as the oaks, were broken off there may have been gusts of wind which increased the severity of the damage locally. Some of the trees which were merely bent over would have subsequently recovered, probably, if the sudden putting forth of the foilage a few weeks later had not held them down through sheer weight of the leaves. In support of this statement it was noticed by the forest officers in Pisgah Forest that many young trees which were borne down by the ice until their crowns were within a few feet of the ground, bent down after the coming of the leaves until their crowns touched the ground. Such trees can not now regain their former erect position.

In some of the large white pine groves on the private estates about Hendersonville and Flat Rock, N. C., the damage was also excessive. Although over a year has passed since the date of the storm, even now the men in charge of these estates have not been able to rid the groves and woodlands of the ragged appearance of the stands. The effects of the ice will be noticeable for a long time to come. Already the southern barkbeetle (*Dendroctonus frontalis*) has destroyed a large number of the pines. It may be reasonably anticipated that the injured hardwoods will more rapidly deteriorate through the action of fungi which may now find easy access to the interior of the trees.

The shattered tops in Pisgah Forest bear evidence of greater damage from natural causes than all the timber-felling crews would make in many years of careless cutting.

NOTE ON THE PRECEDING.

Mr. Rhoades describes very clearly the damage by ice to the timber in the vicinity of Hendersonville and Saluda, N. C. Unfortunately ice storms [1] of this kind are by no means infrequent in the Appalachians south of Pennsylvania. I have been struck in examining a great deal of the old forest, especially that of the mountain slopes between elevations of 1,200 and 4,000 feet, with the general prevalence of ice damage to the timber. In the mountains an ice storm is often limited to a belt or zone which may have an altitudinal range of only a few hundred feet, it being possibly so cold above this elevation that the rain falls as snow or hail, and so warm below it that there is no freezing; yet such a storm may extend for many miles along the mountains within this narrow belt.

Over certain sections, as on the Massanutten and Shenandoah Mountains in Virginia, the general appearance of the forest seems to indicate that practically all of it has been injured by ice during some period of its existence. It is frequently the case that ice damage occurred so many years ago that the trees have replaced their stripped crowns. There are several signs, however, which indicate that a forest has passed through such a crisis even though it may have been remote. In the case of poplar, linn, cucumber, chestnut, and some other species having comparatively brittle wood, the stubs of the larger branches which were broken are tipped or even feathered with numerous small, mostly adventitious, branches. Oaks and hickories having tougher wood frequently have the entire upper portion of their crowns destroyed by the breaking of their central stems. The ultimate result of this is the development of very broad and flat mushroom-like crowns on trees which have been so mutilated. This form of crown is more lasting than the preceding and after a long period is a surer indication of ice damage. Stands have been examined in which the date of the storm, based on the estimated time of development of the mushroom crowns, was placed more than a hundred years ago. During this interval the branchy crowns of the chestnuts had nearly assumed a normal appearance. In many cases a shoot on a side, often on a nearly horizontal branch, developes into a new leader. In time a new crown of normal shape may form around this leader—but there will be an offset in the stem of the tree at the point of development of the new leader.[1]

Another and very lasting deformation, which takes place particularly in young stands which are so crowded that the stems are slender, is the bending over of the stems without breaking. Under the weight of ice the crowns of slender young hickories, even of trees 60 to 70 feet high, will sometimes touch the ground without the stems breaking. Such bent-over stems seldom right themselves, and since bending in this manner is practically limited to young trees the wood of which has not yet become brittle, it is an indication of ice damage which persists for a very long period. The presence in a stand of a number of old trees which are bowed in this manner is an almost certain sign of past ice damage of great antiquity. At the present time there is on Massanutten Mountain in Shenandoah County, Va., not a great distance from Woodstock, a young stand in which in many places the slender oaks and hickories, many of them 10 to 14 inches in diameter, have been bent into an almost inextricable tangle. On account of the youth of these trees comparatively few were broken. It is safe to say that the signs of this storm will be written in this stand for a century unless the injured trees are cut out.

As Mr. Rhoades states, the breakage by ice is a predisposing cause of diseased timber. It is in fact one of the causes of the large amount of wormy and fungous-infested timber of middle age which is to be found throughout certain sections. For this reason ice damage must be reckoned with as an important factor in developing any system of forest management in certain areas which are prone to such storms. Some of the windshake is also probably traceable to the trees bending or swaying under the stress of ice.

The recognition of ice injury of a distant past date in a stand is frequently extremely important in appraisal. The diseased condition of the tops and the wormy timber result in a material lowering of the grades of lumber below what would normally be looked for in trees having no other external indications of defect. Red oak along upper crests, which might otherwise be expected to cut out largely No. 1 common and better lumber, would contain an unaccountable proportion of sound wormy stock, a defect which is rather unusual for this species. Similar deterioration would take place in other species.—*W. W. Ashe, Forest Inspector Forest Service.*

[1] See article on "Definition of Sleet" in MONTHLY WEATHER REVIEW, May, 1916, 44: 281–286.

[1] In June, 1917, in company with Mr. J. H. Fahrenbach, of the Forest Service, I noted the damage caused to timber along the Blue Ridge Mountains in Amherst County, Va., by a recent ice storm. It was not difficult to select trees which, through the development of such offset leaders, showed that they had been injured by two previous storms, which were apparently about 14 and 35 years before the last one.

HOURLY FREQUENCY OF PRECIPITATION IN CENTRAL OHIO AND ITS RELATION TO AGRICULTURAL PURSUITS.

By HOWARD H. MARTIN, Observer.

[Dated: Weather Bureau Office, Columbus, Ohio, July 30, 1918.]

It has been shown by Kincer[1] that the hourly frequency of precipitation and its distribution throughout the daytime and nighttime hours is of importance to the agricultural pursuits of a given State or district. Also, that when grain crops alone are considered, the district favored with a preponderance of nighttime rains is most favorable to farming.

Kincer has also shown that eastern Nebraska, represented by Lincoln, receives 66 per cent of all precipitation occurring between April and September during the nighttime, or between 8 p. m. and 8 a. m., seventy-fifth meridian time; that southern Georgia, typified by Thomasville, receives only 28 per cent; and the Gulf coast, typified by New Orleans, receives only 25 per cent.

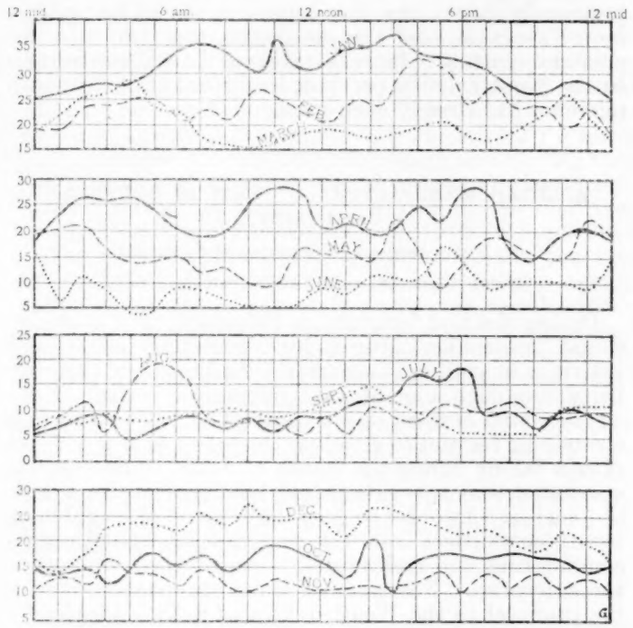

FIG. 1.—Hourly frequency of precipitation at Columbus, Ohio, by months, 1906–1917.

Central Ohio, typified by Columbus, represents an intermediate distribution, 42 per cent of the precipitation that occurs during the growing season being recorded at night.

This might seem detrimental to central Ohio, for, as Kincer further points out:

> After a daytime shower the hot sunshine usually causes rapid evaporation and crusts the cultivated soil, so that little or no benefit and often actual harm results. When the summer showers occur at night, the moisture penetrates the soil to a much greater depth, little evaporation occurs, usually crusts are not formed, and a maximum of benefit results.

Yet central Ohio exceeds eastern Nebraska in the yield per acre of both wheat and corn, 50-year averages considered. With this in mind, it is the purpose of this paper to present by months and by seasons the peculiarities of the diurnal rainfall distribution at Columbus, which, it seems safe to assume, is typical of central Ohio.

Figure 1 represents the hourly frequency of precipitation at Columbus, by months. At first glance there would seem to be no similarity existing between any two of the months, but a closer study will reveal a maximum frequency during the late afternoon hours from January to July, inclusive. There is also a secondary maximum during the early morning hours, at about sunrise or somewhat before. These maxima are not so evident during the other months of the year although they are indicated in the December graph.

Figure 2 shows the hourly frequency of precipitation for Columbus by seasons compared with that for New Orleans, La.[2] Here it is seen that the morning maximum at Columbus is primary during the spring months, attaining its greatest frequency about 1:30 a. m., 90th Meridian Time. In summer the morning maximum (6 a. m.) and the afternoon maximum (5 p. m.) show about the same

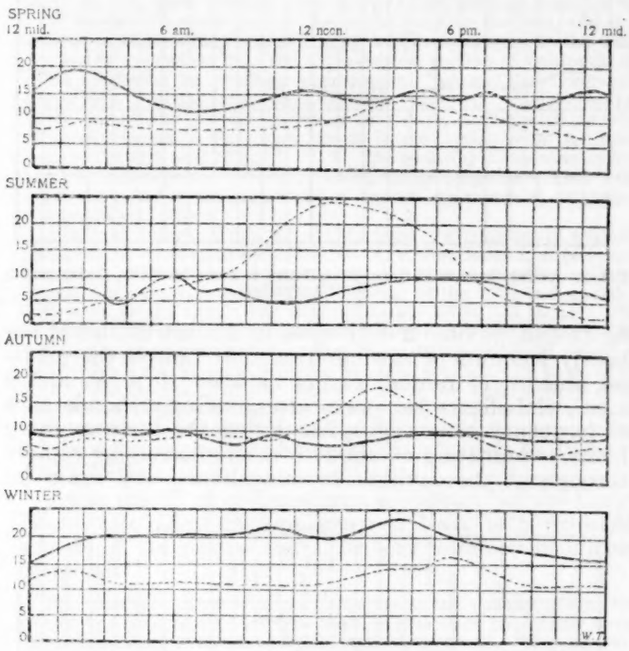

FIG. 2.—Hourly frequency of precipitation in central Ohio compared with that of the Gulf coast. Solid line, Columbus, Ohio; broken line, New Orleans, La., 1906–1917.

frequency, although the afternoon maximum is maintained for a longer period. During autumn it can not be said that there are any pronounced maxima or minima, the frequency values showing a decidedly equable distribution; while in winter, the afternoon maximum again asserts itself, appearing about 4 p. m., or near sunset. The values in this figure have been smoothed by means of the formula, $(a+2b+c)\div 4=F$, where F is the frequency.

It has been found that excessive precipitation in central Ohio is not so frequent as in the Plains States or on the Gulf coast. During a period of 14 years, 1904–17, inclusive, only 76 showers occurred at an excessive rate, the growing season, April to September, considered. The average time of occurrence is 2:30 p. m., the earliest being 12:54 p. m. in May and the latest, 4:54 p. m. in April. It has also been found that the precipitation in central Ohio occurs for the most part in the form of light, beneficial showers. The heavier amounts at ex-

[1] *Kincer, Joseph Burton.* Daytime and nighttime precipitation and their economic significance. MONTHLY WEATHER REVIEW, November, 1916, 44: 628–633.

[2] *Coberly, E. D.* Hourly frequency of precipitation at New Orleans, La., this REVIEW Sept., 1914, 42: 537–538.

cessive rates are often more or less destructive to vegetation and are sometimes accompanied by hail and high winds.

Figure 3 shows a marked difference in the diurnal distribution of the rainfall frequency during the growing season, April to September, for the three districts represented by Lincoln, Thomasville, and Columbus; and

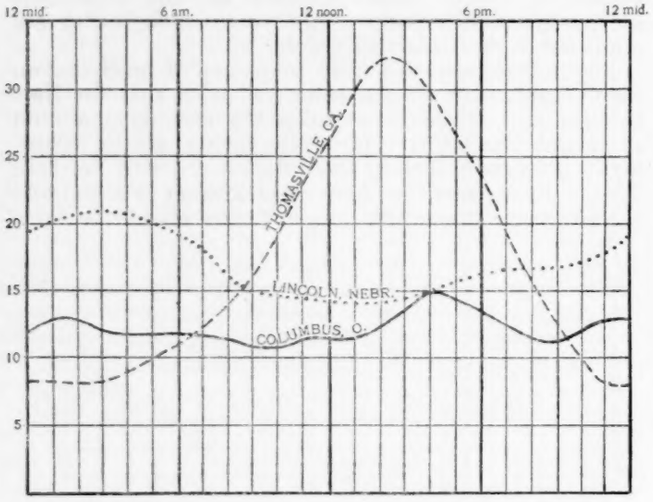

FIG. 3.—Average number of times precipitation occurred by hours, during season, April-September.

figure 4 shows similar differences in the distribution of the hourly amounts of precipitation. At Lincoln the greatest amount of rainfall occurs between 10 p. m. and 2 a. m., while figure 3 shows a corresponding preponderance of frequency of precipitation during the early morning hours, culminating at about 3 a. m., decreasing rapidly throughout the daylight morning hours, and again in-

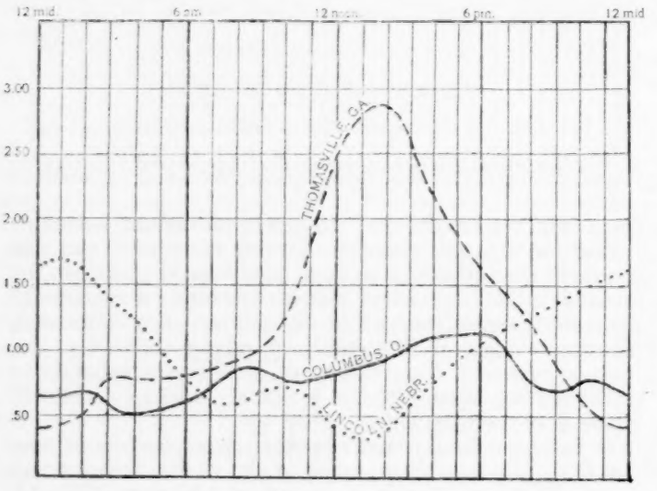

FIG. 4.—Average hourly amounts of precipitation for season, April-September.

creasing late in the afternoon to midnight. At Thomasville the greatest amount falls between 10 a. m. and 6 p. m. During the early morning hours the precipitation is least frequent, increasing rapidly with the advance of the sun, attaining a maximum at approximately 2:30 p. m., and decreasing rapidly until midnight. At Columbus the greatest amount falls between about noon and 7 p. m., with the actual maximum between 4 and 6 p. m. The frequency shows a slight maximum at about 2 a. m., decreasing slightly, then maintaining an equable distribution until about 2 p. m., after which it increases, attaining a primary maximum at about 4 p. m., then decreasing until about 9 p. m., and increasing thereafter.

Rarely during the summer months does a cloudy day follow a nighttime shower. May it not be that precipitation falling two hours before sunset, or thereabouts, will suffer only slight evaporation for a period of 15 hours or more? Consequently the rainfall permeates the soil to a greater extent, and a maximum of benefit results. On the contrary, with the maximum frequency in the morning scarcely three hours before sunrise, the rainfall has much less opportunity to enter the ground to any considerable depth before evaporation takes place under the influence of the sun's rays. There is, of course, probably less crusting of the soil than where showers occur during the early hours of daylight. The total amount of rain falling during the period, April to September, inclusive, is slightly greater at Lincoln than at Columbus; but as previously shown, the distribution at the latter point is more favorable, and this no doubt, together with the greater opportunity for penetration of the soil, contributes to the greater yields per acre in central Ohio to which reference has already been made.

ALLEGED MANUFACTURE OF RAIN IN SOUTHERN CALIFORNIA.

By FORD ASHMAN CARPENTER, Meteorologist.

[Dated: Weather Bureau, Los Angeles, Cal., May 8, 1918.]

During the first fortnight in February, 1918, a professional "rainmaker" began his preliminary advertising activities in southern California. As a result of this publicity campaign one of the commercial bodies of the smaller cities entered into a contract to pay him $300 as a retaining fee and to give him thereafter $1,000 per inch of rain falling during the month of April. This contract stipulated that this rate would hold good up to a total of 5 inches. In order to gain the support of neighboring towns, committees from this organization visited nearby communities and endeavored to enlist their support in the enterprise. Nearly all of those approached referred the proposal to the Weather Bureau at Los Angeles for advice. In discussing the matter with the applicants it was expedient not only to go into the cause of rain in general, but to bring to their minds the history of alleged rainmaking in southern California during the past 20 or 25 years. Fortunately, the writer is personally familiar with the circumstances attending four or five such attempts made in this district during the past score or more of years while he was in charge of the San Diego station of the Weather Bureau and later of the Los Angeles station.

History of local rain making.—The literature of attempts to manufacture rain is so extensive that it is not possible to enumerate even general titles in a brief article. However, all methods as yet proposed are either wholly inefficient, as, for instance, cooling with liquid air, or scientifically absurd, like the exploding of bombs.

The arid and semiarid portions of the United States have been the scene of several attempts at rain making and some of these experiments have been conducted with Federal, State, and municipal aid. Confining our attention to occurrences in recent years, and to activities in the southern part of California, it is found that the rainmaker flourishes in January or February of a season

which up to that date has been characterized by deficient rainfall. During the past 22 years there have been six attempts at rainmaking in this region and nearly all of the operations took place during these months. The first notable example occurred in 1897, being followed later by similar operations in 1900, 1905, 1912, 1916, and 1918. The initial pseudo-scientific venture was personally investigated by the writer. As one of the most notable of local rainmakers became interested in the work and adopted it as a profession about that time it may be well to give some of the details of the operations. A committee from the chamber of commerce of San Diego collected scraps of zinc from many citizens, some householders even sacrificing the sheets of zinc from under their stoves for that purpose. In addition to the salvage committee there were others who collected funds wherewith to purchase sulphuric acid. Several public-spirited citizens ascended the hills about the town and liberated hydrogen gas by pouring the diluted acid on the scraps of zinc. Although much time and labor, to say nothing of several hundred dollars, were spent, the efforts of the rain-making committee were not crowned with success. Three years later another attempt was made, this time by an individual who instigated a "contract" system, whereby he was to receive so much per inch if it rained and nothing except his expenses if it did not. By utilizing the newspapers in a publicity campaign and playing upon the credulity of some of the people he was enabled to make a precarious existence, carrying on his operations in the succeeding dry seasons of 1905, 1912, 1916, and 1918.

The rainmaker's methods of operation.—At the very beginning of his operations the rainmaker's mental attitude was one of honest inquiry. My recollection of meeting one of them in the early years of rainmaking is that he possessed a limited education; he lacked, by nature, the ability to differentiate cause from effect. From his early failures he evolved a system of "no rain, no pay," which became very attractive even if the assertion was not strictly true, for he always insisted upon receiving his expenses in advance, which usually amounted to several hundred dollars. The attempts at rainmaking in 1905 were noted as follows in the MONTHLY WEATHER REVIEW:[1]

FAKE RAINMAKING.

During the past winter the associated conditions referred to (pressure distribution) have prevailed, and they resulted in frequent and generally excessive rains not alone in southern California but in all of the immense territory that extends thence eastward to Texas. It is, therefore, apparent that the rainfall which was supposed to have been caused by the liberation of a few chemicals of infinitesimal power was simply the result of general atmospheric conditions that prevailed over a large area. It is hoped that the people of southern California will not be misled in this matter and give undue importance to experiments that doubtless have no value. The processes which operate to produce rain over large areas are of such magnitude that the effects upon them of the puny efforts of man are inappreciable.

In 1912 a rainmaker appeared in southern California claiming to induce rain by using a secret gas. On October 1, 1912, the writer made the following report to the Chief of Bureau:

His success in obtaining promises of money has been from people who are willing to take a chance. They figure that if it does not rain they will not be out anything, and if it *does* rain they will be so jubilant that they can afford to spare the sums subscribed. It has frequently happened, however, that when the rains did come the people in their joy and satisfaction over the good yield that they anticipated forgot the rainmaker.

He is not willing to back his promises with any money. A farmer once told me: "A rainmaker was out here one day when those hills were white with drifting clouds. Says I: 'Professor, I've a thousand acres that must have rain within three days. If you will make it rain 2 inches in 72 hours I'll give you a written promise and my check for $2,000. I only require that you put up $200 in escrow to be forfeited if it don't rain." "And," said the farmer, "the rainmaker would not take me up. And, furthermore, it rained 4 inches within 48 hours, and that with a northwest wind."

The dry autumn of 1915 gave another opportunity for a rainmaker, and this time he was successful in getting the city council of San Diego to enter into a contract for as much as $10,000 to produce rain in January. Concerning the heavy rain during the latter part of January, the following appeared in the MONTHLY WEATHER REVIEW:[2]

It seems reasonable to suppose that the storm which swept over Hawaii on the 18th–19th passed over California on the 27th. It is charted as Low No. XIV, Chart III. About a week previous Low No. X, Chart III, passed inland over the middle California coast on the 17th, crossed the south-central part of the State on the 18th, and then moved northeastward into Wyoming by the morning of the 19th. During its movement over the south-central portion of California the storm slackened its progressive movement, meanwhile giving very heavy rains over the counties of southern California. Light rains had fallen during the previous three or four days, and conditions were unusually favorable for a high run-off in connection with the heavy rains of the 17th and 18th. * * * The resulting floods were severe, and much damage was done to railroads, bridges, highways, land under cultivation, and to the harbor of Los Angeles, by reason of the mass of silt deposited thereon.

A second deluge of rain descended upon the counties of southern California in connection with Low No. XIV, mentioned in a preceding paragraph. The second storm was of much shorter duration. At San Diego, Cal., the rain began at 7:18 p. m. of the 26th and ended at 7:45 p. m. on the 27th. The total fall amounted to 2.41 inches. This rainstorm was attended by unusually high winds for southern California, the average velocity at San Diego being about 30 miles per hour, with a maximum of 54 miles from the south at 4:29 a. m. of the 27th. The reservoirs in the county whence the water supply of the city of San Diego is drawn were already nearly full as a result of the rains of the previous week, and all of them, evidently, were not in a condition to withstand the added strain put upon them by the rains of the 26th–27th.

As to the effect of this storm, a bulletin[3] of the United States Geological Survey issued in May, 1918, gives the extent of the storms and their serious effect on life and property.

The rains that swept southern California in mid-January, 1916, converted the streams into torrents that overran their banks and devastated wide areas of the most fertile land of the State. The rains were heaviest and the floods most disastrous in San Diego County, but they were also very heavy in parts of Riverside, San Bernardino, Los Angeles, and Ventura Counties, and they wrought widespread ruin throughout the region that extends southward from Santa Clara River to the Mexican boundary and westward from the north-south ranges of San Bernardino and San Diego Counties to the ocean. * * *

Conclusions.—It is the uncertainty of rainfall in southern California that doubtless makes this region attractive to the rainmaker. Rain is here the least dependable meteorological element; for example, during the present season in Los Angeles, 51 weeks elapsed between the last rain of one-half an inch in February, 1917, and the next rain of like amount in 1918.

An examination into the methods of the rainmaker shows a disregard of physical laws, and a review of the history of rainmaking affords no proof of his success.

By far the most important feature of his work consists in playing upon the credulity of mankind. It is therefore a psychological rather than a meteorological problem, for the fundamental factors are those of the mind and not of matter.

[1] Fake rainmaking, A Letter from the Chief of Bureau. MONTHLY WEATHER REVIEW, April, 1905, 33: 153.

[2] Floods of January–February, 1916, in Southern California, MONTHLY WEATHER REVIEW, January, 1916, 44: 28–29.

[3] Southern California Floods of January, 1916, Water Supply Paper 426, p. 7.

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR AUGUST, 1918.

By ALFRED J. HENRY, Supervising Forecaster.

PRESSURE DISTRIBUTION OVER THE NORTH PACIFIC AND ALASKA.

Pressure at Midway Island was above normal from the 5th to the 13th and again from the 19th until the end of the month. There were but two periods of low pressure, the first reached its minimum on the 4th and the second on the 16th. At Honolulu pressure was quite uniformly below the normal, as in previous months.

Pressure at Alaskan stations was generally below normal from the 1st to the 11th, the greatest depression occurring about the 9th. There was, however, a slight rise to normal and a little above from Valdez south to San Francisco on the 4th and 5th. After the 11th pressure alternately rose and fell, the amplitude of the rises and falls being small and probably without significance so far as the weather in the United States is concerned.

In the United States the principal rise in pressure occurred in connection with High area No. IV–A. This HIGH can not be traced back to Alaska or the Canadian Northwest; we are therefore constrained to believe that it originated in the Hudson Bay region and moved thence southeastward.

WEATHER OF THE MONTH.

The rainfall was quite irregularly distributed, many places receiving moderately heavy rains, while drought more or less severe prevailed in other places, especially in northeastern districts. East of the Rocky Mountains temperature was considerably above normal, the greatest excess being in the middle Mississippi Valley; west of the Rocky Mountains relatively cool weather prevailed. The intense heat in the Great Central Valleys during the first decade was the conspicuous event of the month. (*See* p. 361, this REVIEW, for details of this event.)

HIGHS.

Eight HIGHS have been plotted on Chart II, six of which were of North Pacific origin and the remaining two evidently originated in northern Manitoba. The North Pacific HIGHS seem to have been offshoots from the subpermanent HIGH that overlies the Pacific west of the Washington and Oregon coast. Numbers II and IV did not pass wholly across the continent, thus confirming the belief held by many forecasters that unless central pressure in a North Pacific HIGH in summer is above 30.20 inches it will not persist long enough to cross the interior of the continent. Pressure was high on several occasions along the West coast but there was no progressive movement. The first of these stationary highs appeared at Triangle Island on the 11th with initial pressure of 30.28 inches. The second stationary HIGH appeared at North Head, Wash., on the 22d, with central pressure of 30.30 inches. Surface pressures in both of these HIGHS gave no indication of a progressive eastward movement.

High area numbered IV–A was the most pronounced HIGH of the month. As HIGH No. IV reached the upper Lake Region on the 15th its eastward movement ceased. At this time rising pressure over northern Manitoba indicated the formation of an independent HIGH. By the morning of the 16th pressure at Salt Ste. Marie, Mich., had risen to 30.22 inches, and at Cochrane, northern Ontario, to 30.20 inches. On the p. m. map of the 16th pressure had fallen at both Cochrane and Sault Ste. Marie, but on the morning of the 17th pressure had risen at the first-named to 30.36 inches, and continued rising during the next 24 hours, reaching a maximum of 30.46 inches on the morning of the 17th. Central pressure in this HIGH continued to increase, reaching 30.52 inches at Canton, N. Y., on the morning of the 19th. At that time this HIGH was probably the controlling factor of the weather over the northern and central portions of the American continent. The failure of the stationary areas of high pressure hereinbefore mentioned to progress eastward seems to have been due to the blocking effect of HIGH No. IV–A in the St. Lawrence Valley and New England.

It seems to be established that the progressive movement of LOWS is at times greatly diminished by the pressure distribution 1,000 miles or more to the eastward; there is therefore no apparent reason why the eastward progression of HIGHS should not be retarded or even suspended temporarily by the pressure distribution far to the eastward.

LOWS.

Thirteen LOWS classed as follows have been plotted on Chart III: Alberta, 6; Central, 3; North Pacific, 2; Northern Rocky Mountains, 1; Atlantic coast (south of Virginia) 1, and one tropical disturbance plotted as No. III. In addition to these, many shallow barometric depressions with weak or but imperfectly developed cyclonic circulation were observed at various times during the month in some part of the Rocky Mountain and Plateau regions or in the upper Mississippi and lower Missouri Valleys. Pressure in the last-named district was abnormally low during the greater part of the month, and that region seemed to be the locus of origin of shallow depressions, as, for example, No. I–A, V–A, and XI–A, all secondaries developed in the southwest quadrant of depressions that moved east-northeast over Canada north of the field of observation. This seems to have been the outstanding feature of the movement of LOWS during August, 1918.

Low No. X apparently developed on the Carolina coast during the night of the 23d. On the morning of the 24th the center was at Wilmington, N. C., and the pressure was decreasing rapidly at that place but not at surrounding stations. Storm warnings were ordered for the North Carolina and Virginia coasts and the further development of the disturbance was awaited. Rather unexpectedly the disturbance moved very slowly—about 8 miles an hour for the first 24 hours—reaching the Virginia Capes on the morning of the 25th. Its subsequent movement was probably northeastward over the Gulf Stream. The storm, while severe on the immediate coast, did not extend more than 50 miles inland. Considerable damage was done at beach resorts and towns along the North Carolina and Virginia coasts.

The unprecedented heat from a forecasting standpoint is treated elsewhere in this REVIEW, page 361.

TROPICAL DISTURBANCES.

Tropical storm, August 1–6.—The center of this storm did not pass near any observing station and it was not encountered by any vessels navigating the Caribbean Sea and Gulf of Mexico. The cable reports of the 1st showed that a disturbance was evidently south of Bridgetown, Barbados. The disturbance moved west-northwest, passing to the south of Jamaica some time in the afternoon of the 3d.

It seems to have passed across the Yucutan Peninsula or possibly through the Yucutan channel Sunday afternoon, and was not again observed until Tuesday morning, when falling pressure and freshening winds from the southeast indicated that it was approaching the Gulf coast. Advices of the presence of a tropical storm had been previously given. It now remained, however, to determine the probable point of contact with the coast. At 1:30 p. m. the following advices were issued:

Hoist hurricane warning Louisiana and Texas coast from Galveston east. Disturbance probably strike the coast between Galveston and mouth Sabine River.

The hurricane struck the Louisiana coast a few miles east of Calcasieu Pass, or about 30 miles east of the mouth of the Sabine. The path is indicated on Chart III. The storm passed a little west of north through the parishes of Cameron, Calcasieu, and Beauregard, La., and thence into Newton County, Tex., near where the Gulf Coast Line Railroad crosses the Sabine River—a total distance of about 80 miles.

Following is a detailed account of the storm prepared by Assistant Forecaster R. A. Dyke, New Orleans, La.:

The first indications of the disturbance were the cirrus and cirrostratus clouds, recorded in observations in the early afternoon and evening of the 5th and the early morning of the 6th. At New Orleans, within the two hours following 7 a. m. on the 6th, lower clouds accumulated and the cirrus clouds were soon hidden from view.

The pressure distribution over the United States on the 5th was such as is usually accompanied by southeast winds at New Orleans, and southeast winds prevailed from 11 a. m. of the 5th to 2 p. m. of the 6th, after which the wind was from the south. The fact that the disturbance did not cause northeast or even east winds at New Orleans during any time while it was moving northwestward across the Gulf is one indication of its small diameter, for the general pressure conditions exercised only a weak influence on the direction of the wind. The wind velocity, when the storm was nearing the coast, did not exceed 34 miles an hour at Burrwood and 25 miles at New Orleans. The direction of the wind at Burrwood was very similar to the direction at New Orleans except that it was east at Burrwood at the 7 p. m. observation of the 5th.

The center of the storm reached the Louisiana coast a few miles west of the village of Creole, and east of Calcasieu Lake, in Cameron Parish. It moved in a straight line in a NNW direction, passing near or through Westlake, a town just west of the city of Lake Charles. Slightly west of De Quincy it crossed the Sabine River into Texas a few miles below Merryville, La. At this point the storm was probably diminishing, though still violent, as is shown by the destructive winds at Merryville. The length of this path is about 90 miles, and if we consider the respective shifts of the wind from east to southeast at the ends of the path, which occurred about five hours apart according to reports received, the approximate average rate of progress over this portion of the course of the storm was 18 miles per hour.

The area in which considerable destruction occurred was about 25 miles wide, and winds of great force lasted only two to three hours. The storm was about 100 miles in diameter, but approaching the outer edges the damage was slight or entirely absent.

Besides the wind record at Port Arthur, Tex., on the western edge of the storm, we have the partial record at Lake Charles, where the velocity increased on the 6th from 12 miles an hour at 8 a. m. to 24 miles at noon, 36 miles at 2 p. m., 48 miles at 2:30 p. m., and 80 miles an hour in the five-minute period terminating at 2:58 a. m., with an extreme velocity of at least 100 miles an hour. It was at this point that the anemometer was put out of service by the wind or flying débris.

We have not succeeded in obtaining reports of barometer readings within the hurricane.

Two reports of tides have been received. At Johnsons Bayou, 10 miles east of the mouth of Sabine Pass and 28 miles west of Calcasieu Lake, the tide was 2 feet and 5 inches above normal. At Morgan City the tide rose 3 feet. Between these points the tide was doubtless somewhat higher, especially along the coast in the eastern portion of Cameron Parish.

The distribution of rainfall was rather uniform, being in the neighborhood of 2 inches at most places within the storm area and slightly exceeding this just outside the storm area and near the coast. Very few reports of thunder and lightning were received and these were not from places close to the center of the storm. Many persons within the area of violent winds stated that there was no thunder or lightning.

Thirty-four deaths are reported as due to the storm and the number of persons injured is more than twice that number. Eleven deaths occurred at Lake Charles and three at Gerstner Field. The other deaths were in Cameron Parish and in small towns near the center of the storm.

The damage to property is roughly estimated at $5,000,000. This includes damage at Lake Charles, Gerstner Field, and Sulphur, La., and to crops and standing timber; but it does not include losses from dwellings blown down in numerous villages, and live stock, possibly numbering a hundred, drowned in Cameron Parish. A mail and passenger steamboat was sunk in Prien Lake on the trip from Cameron to Lake Charles, but the passengers were saved and the boat can probably be refloated, as it sank in shallow water. Some indirect damage resulted from fires, fortunately not extensive, though causing the loss of a few very valuable properties. The greater part of the rice crop was not sufficiently advanced to suffer much damage, and was benefited by the needed rains. Where cotton and corn are grown there were considerable losses.

Summer time (75th meridian) is used in this report.

Second tropical disturbance.—The second tropical disturbance of the month passed Barbados, moving to the west, during the forenoon of the 22d. The maximum wind at Bridgetown was 48 miles from the southeast and the lowest pressure 29.84 inches. These data, however, are inconclusive as to the distance of the center from that point. During the next 72 hours reports from land stations merely indicated a disturbance over Central Caribbean region probably of little intensity. On Sunday morning, August 25, the observer at Kingston, Jamaica, reports: "Center passed south Jamaica moving west yesterday afternoon." Subsequent reports indicate that the disturbance, much diminished in intensity, passed inland over Honduras Sunday night and dissipated over that region during the next 48 hours. The weather over the western Caribbean was unsettled with low pressure for the remainder of the month.

Both disturbances moved with rather high speed, the average being perhaps slightly above 15 miles per hour. The average rate before recurving is about 12 miles per hour.

WARNINGS FROM OTHER DISTRICTS.

Chicago, Ill., forecast district.—No warnings were issued during the month.—*Ernest H. Haines, Meteorologist.*

New Orleans, La., forecast district.—A tropical storm moved into western Louisiana during the afternoon of August 6, for which warnings were issued as follows: Northeast storm warnings were ordered for the Louisiana coast, 8:40 a. m., northwest storm warnings for the Texas coast, 12:30 p. m., and hurricane warnings for the Louisiana coast. No other storm occurred, and no further warnings were issued during the month.—*I. M. Cline, District Forecaster.*

Denver, Colo., forecast district.—Low barometric pressure prevailed during the fore part of the month, attended by frequent showers in large portions of the district. The weather was generally fair during the latter half of the month under the influence of moderately high pressure. Cool weather for August predominated in the western part of the district. No general warnings were issued.—*Frederick W. Brist, Assistant Forecaster.*

San Francisco, Cal., forecast district.—Much unsettled weather prevailed in this district during the first half of

August, but rainfall was light and mostly confined to mountain localities. Temperatures during this period were as a rule slightly below normal. Beginning about the 15th a rainy period occurred in the North Pacific States that lasted a week, and following this temperatures above normal prevailed in all sections until the close of the month. Rain came too late in the North Pacific States to benefit grain and early planted truck crops, but it was of immense value in putting out forest fires and preventing new ones from starting. Prior to this rainy spell the forest fire hazard was acute, owing to the previous long dry period, which followed a winter of light snowfall in the mountains. When the snowfall is light in the mountains vegetation on their slopes dries early in the season. In consequence the fire risk covers a longer period, thus making possible a greater number of fires as well as enhancing the difficulties to be met in keeping them under control.

Fire-weather warnings were issued on the 12th, 20th, and 30th for high temperatures and gentle winds, and on the 14th the Forest Service people were advised that conditions were favorable for thunderstorms in the mountains during the next day or two. These warnings were all verified and undoubtedly served a useful purpose. On August 1 small-craft warnings were issued for Tatoosh Island and Neah Bay only. No other warnings were ordered during the month, and none were needed.—*E. A. Beals, District Forecaster.*

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, AUGUST, 1918.

By ALFRED J. HENRY, METEOROLOGIST, IN CHARGE.

Dated: River and Flood Division, Weather Bureau, Sept. 30, 1918.]

Heavy rains during the first week of August caused moderate floods in the Santee, Saluda, and Edisto Rivers of South Carolina and in the Broad River of Georgia. Elsewhere in the United States flood stages were not reached during the month.

The only losses sustained were confined to the Santee and Congaree basins and are estimated as follows: Prospective crops, $3,000; live stock, $850; and suspension of business, $150.

Owing to timely warnings, live stock valued at $36,000 were driven from the flooded districts.

TABLE 1.—*Flood stages in the Atlantic drainage during August, 1918.*

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
Santee:	*Feet.*			*Feet.*	
Rimini, S. C.	12	3	9	13.4	7
Fergusson, S. C.	12	4	10	12.9	8-9
Saluda:					
Pelzer, S. C.	7	.....	.....	6.0	2
Chappells, S. C.	14	3	4	17.0	4
Edisto:					
Edisto, S. C.	6	.....	.....	5.2	6-7
Broad:					
Carlton, Ga.	11	3	3	12.0	3

MEAN LAKE LEVELS DURING AUGUST, 1918.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Sept. 5, 1918.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.[1]			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during August, 1918:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	602.42	581.79	572.64	246.43
Above or below—				
Mean stage of July, 1918	+0.16	−0.13	+0.06	−0.42
Mean stage of August, 1917	−0.27	−0.01	−0.93	−0.92
Average stage for August, last 10 years	−0.20	+0.95	−0.04	−0.22
Highest recorded August stage	−1.51	−1.72	−1.47	−1.83
Lowest recorded August stage	+0.82	+1.94	+1.26	+2.08
Average relation of the August level to—				
July level	+0.3	±0.0	−0.2	−0.3
September level	+0.4	+0.2	+0.3	+0.4

[1] Lake St. Clair's level, in August, 575.93 feet.

SECTION V.—SEISMOLOGY.

SEISMOLOGICAL REPORTS FOR AUGUST, 1918.

W. J. HUMPHREYS, Professor in Charge.

[Dated: Seismological Investigations, Weather Bureau, October 2, 1918.]

TABLE I.—*Noninstrumental earthquake reports, August, 1918.*

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
1918.		CALIFORNIA.								
	H. m.		° ′	° ′			*M. s.*			
Aug. 1	19 46	Calexico	32 41	115 30	3	1	01	Faint	Rumble and bump	H. M. Rouse.
3	18 30	Stanford University	37 25	122 10	3	1	03	None		Prof. S. D. Townley.
12	16 30	Coulterville	37 43	120 13	3	1	04	Loud	Rumble in N., then an abrupt twist N–SW.	W. H. Dudley.
		North Fork (15 miles NE at Kaiser Diggings, Madera Co.)	37 20	119 20	4	1		None		U. S. Forest Service.
17	8 45	Calexico	32 41	115 30	4	3	01	Faint	Rumble; then 3 sharp, rapid, downward bumps.	H. M. Rouse.
	8 49	Calexico	32 41	115 30	4	1	01		A sharp downward bump	H. M. Rouse.
20	10 41	Eureka	40 48	124 11	4	1	10	Rumble	Then a bump and twist E–W.	L. M. Monfort.
	18 45	Morgan Hill (Santa Clara Co.).	37 08	121 38	5	1		None		San Jose Evening News.
24	16 29	Calexico	32 41	115 30	4	1	01	None	Abrupt jerk SE.–NW.	H. M. Rouse.
		MAINE.								
21	4 12	Bridgton	44 03	70 42	5	2	13	Loud	Rumble. Abrupt rocking NE.–SW.	Charles L. Chadbourne.
		Cape Elizabeth	43 35	70 14			Few			Frank W. Sparrow.
		Duck Pond Lake	43 46	70 21						Portland Daily Press.
		Lewiston	44 05	70 12						Portland Express Advertiser.
		Little Sebago Lake	43 53	70 24					Water on eastern shore of lake dropped about 4 inches.	George E. Sawyer.
		Norway	44 12	70 32	8				Chimneys fell	Charles L. Chadbourne.
		South Paris	44 13	70 30	7–8				Bricks fell from chimneys. Doors flew open.	Portland Daily Press.
		NEVADA								
19	10 53	Winnemucca	40 58	117 43	4	1	03	None	Rapid rocking N.–S.	Ray L. Fisher.

TABLE 2.—*Instrumental seismological reports, August, 1918.*

(Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.)

[For significance of symbols see REVIEW for January, 1918, p. 34.]

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
Alaska. *Sitka. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.								
Lat., 57° 03′ 00″ N.; long., 135° 30′ 06″ W. Elevation, 15.2 meters.								
Instruments: Two Bosch-Omori, 10 and 12 kg.								
				V	T_0			
Instrumental constants.. E				10	17			
Instrumental constants.. N				10	15			
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Aug. 15..	.....	eP_N....	12 32 15	5	.....	.....	.....	
		eP_E....	12 35 09	5	.....	.....	.....	
		S_N....	12 42 23	16	.....	.....	.....	
		eS_E....	12 42 27	10	.....	.....	.....	
		M_EI...	12 43 11	10	140	.....	.....	
		eL_N...	12 55 05	.....	.....	.....	.....	
		M_N....	12 57 57	.....	.....	120	.....	
		C_N....	12 59 ..	.....	.....	.....	.....	
		eL_E...	13 01 26	35	.....	.....	.....	
		M_E2...	13 03 45	25	70	.....	.....	
		C_E....	13 10 ..	24	.....	.....	.....	
		F_E....	14 05 ..	16	.....	.....	.....	
		F_N....	14 09 ..	17	.....	.....	.....	
Arizona. *Tucson. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.								
Lat. 32° 14′ 48″ N., long., 110° 50′ 06″ W. Elevation, 769.6 meters.								
Instruments: Two Bosch-Omori, 10 and 12 kg.								
				V	T_0			
Instrumental constants.. E				10	14			
Instrumental constants.. N				10	18			
(Report for August, 1918, not received.)								
California. *Berkeley. University of Californa.*								
Lat., 37° 52′ 16″ N.; long., 122° 15′ 37″ W. Elevation, 85.4 meters.								
(*See* Bulletin of the Seismographic Stations, University of California.)								
California. *Mount Hamilton. Lick Observatory.*								
Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.								
(*See* Bulletin of the Seismographic Stations, University of California.)								
California. *Point Loma. Raja Yoga Academy.* F. J. Dick.								
Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.								
Instrument: Two-component, C. D. West seismoscope.								
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Aug. 28..	.....	.....	.....	.....	50	50	.....	Tremors during 24 hours preceding 15h. 00m.
California. *Santa Clara. University of Santa Clara.* J. S. Ricard, S. J.								
Lat., 37° 26′ 36″ N.; long., 121° 57′ 63″ W. Elevation, 27.43 meters.								
(*See* Record of the Seismographic Station, University of Santa Clara.)								
Colorado. *Denver. Sacred Heart College.* Earthquake Station. A. W. Forstall, S. J.								
Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.								
Instrument: Wiechert 80-kg., astatic, horizontal pendulum.								
Instrumental constants								
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Aug. 5..	.....	.....	.....	.....	.....	.....	.....	Activity on both components from 10h. to 13h.
15	.....	L_N....	13 08 ..	40	.....	*500	.....	P not discernible. Very long record. Seems to be made up of several quakes. Record also disturbed by heavy machinery in motion.
		L_E....	13 13 ..	40	*1,000	.....	.....	
		C.....	13 18 ..	.....	.....	.....	.....	
		L_E....	13 22 ..	20	.....	.....	.....	
		C_E....	13 36 ..	.....	.....	.....	.....	
		L_E....	13 40 ..	20	.....	.....	.....	
		C_E....	13 47 ..	.....	.....	.....	.....	
		L_E....	13 49 ..	20	.....	.....	.....	
		C_E....	13 55 ..	.....	.....	.....	.....	
		L.....	13 57 ..	15	.....	.....	.....	
		C.....	14 32 ..	.....	.....	.....	.....	
		F....	14 43 ..	.....	.....	.....	.....	
17..	.....	.....	.....	.....	.....	.....	.....	Activity from 3h. to 4h.
								NOTE.—No record during July.

* Trace amplitude.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
District of Columbia. *Washington. U. S. Weather Bureau.*								
Lat., 38° 54′ 12″ N.; long., 77° 03′ 03″ W. Elevation, 21 meters.								
Instrument: Marvin (vertical pendulum), undamped. Mechanical registration.								
				V	T_0			
Instrumental constants..				110	6.4			
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Aug. 4	.....	e_N?....	16 20 35	.....	.....	.....	.....	Amplitude small. Phases uncertain.
		e_E.....	16 28 40	.....	.....	.....	.....	
		F.....	16 42 ..	.....	.....	.....	.....	
8	.....	P.....	10 08 29	.....	.....	.....	8,650	
		S.....	10 18 22	.....	.....	.....	.....	
		SREPi.	10 24 30	.....	.....	.....	.....	
		L?....	10 34 30	.....	.....	.....	.....	
		L.....	10 44 30	.....	.....	.....	.....	
		L.....	10 47 30	28	.....	.....	.....	
		F.....	11 50 ..	.....	.....	.....	.....	
15	.....	P.....	12 37 27	.....	.....	.....	5,290	
		S.....	12 44 25	.....	.....	.....	.....	
		eL....	12 50 ..	.....	.....	.....	.....	
		L.....	12 58 ..	.....	.....	.....	.....	
		L.....	13 23 ..	36	.....	.....	.....	
		L.....	14 00 ..	16	.....	.....	.....	
		F.....	15 40 ..	.....	.....	.....	.....	
15	.....	e_E.....	17 51 37	.....	.....	.....	.....	
		S.....	17 52 45	.....	.....	.....	.....	
		eL....	18 10 30	.....	.....	.....	.....	
		L.....	18 38 ..	.....	.....	.....	.....	
		F.....	19 15 ..	.....	.....	.....	.....	
17	.....	P.....	7 03 30	.....	.....	.....	6,520	
		S.....	7 11 34	.....	.....	.....	.....	
		eL....	7 22 30	.....	.....	.....	.....	
		L.....	7 28 ..	24	.....	.....	.....	
		F.....	7 40 ..	.....	.....	.....	.....	
23	.....	e.....	6 56 27	.....	.....	.....	.....	Microseisms.
		eL....	7 34 ..	.....	.....	.....	.....	
		L.....	7 40 ..	20	.....	.....	.....	
		F.....	8 40 ..	.....	.....	.....	.....	
District of Columbia. *Washington. Georgetown University.* F. A. Tondorf, S. J.								
Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W. Elevation, 42.4. meters. Subsoil: Decayed diorite.								
Instruments: Wiechert 200 kg. astatic horizontal pendulums, 80 kg. vertical.								
				V	T_0	ε		
Instrumental constants.. E				165	5.4	0		
Instrumental constants.. N				143	5.2	0		
Instrumental constants.. Z				*80*	*3.0*	*0*		
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Aug. 4	.....	e_N.....	16 28 09	.....	.....	.....	.....	Microseisms. Does not show on E-W component.
		i_N.....	16 29 27	.....	.....	.....	.....	
		F.....	16 37 ..	.....	.....	.....	.....	
8	.....	eP_N...	10 08 19	.....	.....	.....	.....	Heavy microseisms.
		EP_E...	10 09 08	.....	.....	.....	.....	
		eS.....	10 18 29	.....	.....	.....	.....	
		L_E....	10 49 34	30	.....	.....	.....	
		L_N....	10 49 34	28	.....	.....	.....	
		F.....	11 47 ..	.....	.....	.....	.....	
15	.....	eP.....	12 37 39	.....	.....	.....	.....	Record from Bosch photographic seismograph.
		S.....	12 44 31	.....	.....	.....	.....	
		eL....	12 50 24	9	.....	.....	.....	
		M_E....	13 34 08	22	*1,200	.....	.....	
		M_N....	13 50 10	23	.....	*1,100	.....	
		F.....	15 10 ..	.....	.....	.....	.....	
15	.....	e.....	17 51 00	.....	.....	.....	.....	Do.
		S_N....	17 53 11	.....	.....	.....	.....	
		S_E....	17 53 16	.....	.....	.....	.....	
		eL_N?..	18 09 12	.....	.....	.....	.....	
		eL_E?..	18 09 18	.....	.....	.....	.....	
		F.....	19 20 ..	.....	.....	.....	.....	
17	.....	eP_N...	7 03 29	.....	.....	.....	.....	Does not show on E-W.
		S_N....	7 11 34	.....	.....	.....	.....	
		eL_N...	7 25 30	.....	.....	.....	.....	
		L.....	7 28 17	22	.....	.....	.....	
		F.....	7 58 ..	.....	.....	.....	.....	
23	.....	i_E.....	7 56 48	.....	.....	.....	.....	Heavy microseisms. Record faint on E-W.
		e_N.....	7 56 48	.....	.....	.....	.....	
		e_N	8 06 21	.....	.....	.....	.....	
		e_E.....	8 06 37	.....	.....	.....	.....	
		eL_N...	8 33 18	19	.....	.....	.....	
		eL_E...	8 33 30	21	.....	.....	.....	
		L.....	8 40 ..	19	.....	.....	.....	
		F.....	10	.....	.....	.....	.....	[NOTE.—Time of phases is one hour later than at other stations.]

* Trace amplitude.

TABLE 2.—*Instrumental seismological reports, August, 1918*—Continued.

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neuman.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

Instrumental constant.. T_0 18

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	*μ*	*μ*	*km.*	
1918. Aug. 1	.....	e.....	4 54 48	.....	.....	.....	.....	
		M.....	5 01 18	18	*100	.....	.....	
		F.....	5 05 ..	.....	.....	.....	.....	
1	.....	eP.....	11 55 24	.....	.....	.....	.....	
		L.....	11 58 30	21	.....	.....	.....	
		M.....	11 59 54	18	*400	.....	.....	
		C.....	12 04 ..	.....	.....	.....	.....	
		F.....	13 08 ..	.....	.....	.....	.....	
8	.....	P.....	9 57 30	.....	.....	.....	.....	
		S.....	10 05 24	.....	.....	.....	.....	
		L.....	10 14 06	25	.....	.....	.....	
		M.....	10 21 00	19	*5,100	.....	.....	
		C.....	10 30 00	.....	.....	.....	.....	
		F.....	14 43 ..	.....	.....	.....	.....	
15	.....	P.....	12 30 12	.....	.....	.....	.....	Maximum amplitude probably 38 mm. Tremors continued to the beginning of the next 'quake.
		S.....	12 40 18	.....	.....	.....	.....	
		L.....	12 54 00	25	.....	.....	.....	
		M.....	13 03 ..	19	*17,000+	.....	.....	
		C.....	13 32 ..	.....	.....	.....	.....	
		F.....	.....	.....	.....	.....	.....	
15	.....	P.....	17 42 12	.....	.....	.....	.....	
		S.....	17 51 36	.....	.....	.....	.....	
		L.....	18 05 06	25	.....	.....	.....	
		M.....	18 20 00	17	*1,500	.....	.....	
		C.....	18 27 ..	.....	.....	.....	.....	
		F.....	19 55 ..	.....	.....	.....	.....	
17	.....	eP.....	7 17 54	.....	.....	.....	.....	
		L.....	7 38 00	.....	.....	.....	.....	
		M.....	7 49 30	17	*100	.....	.....	
		C.....	7 51 ..	.....	.....	.....	.....	
		F.....	8 42 ..	.....	.....	.....	.....	
22	.....	e.....	8 48 48	.....	.....	.....	.....	
		L.....	8 55 42	.....	.....	.....	.....	
		M.....	9 00 00	18	*100	.....	.....	
		C.....	9 02 ..	.....	.....	.....	.....	
		F.....	9 15 ..	.....	.....	.....	.....	
23	.....	P.....	6 45 30	.....	.....	.....	.....	
		S.....	6 52 30	.....	.....	.....	.....	
		L.....	7 00 24	24	.....	.....	.....	
		M.....	7 06 48	19	*4,600	.....	.....	
		C.....	7 13 ..	.....	.....	.....	.....	
		F.....	10 40 ..	.....	.....	.....	.....	
23	.....	e.....	22 47 42	.....	.....	.....	.....	Possibly an artificial disturbance.
		L.....	22 49 48	.....	.....	.....	.....	
		M.....	22 50 12	18	*1,300	.....	.....	
		C.....	22 56 ..	.....	.....	.....	.....	
		F.....	23 48 ..	.....	.....	.....	.....	

* Trace amplitude.

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′ 58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

		V	T_0	ϵ
Instrumental constants..	E	177	3.4	4:1
	N	205	3.4	4:1

Report for August, 1918, not received.

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 44′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

		V	T_0
Instrumental constants..	E	10	15
	N	10	15

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	*μ*	*μ*	*km.*	
1918. Aug. 8	.....	eL_N...	10 48 ..	27	.....	.....	.....	P and S not discernible.
		eL_E...	10 49 ..	26	.....	.....	.....	
		M.....	10 55 ..	21	10	10	.....	
		C_E....	10 57 ..	.....	.....	.....	.....	
		C_N....	11 02 ..	.....	.....	.....	.....	

Maryland. *Cheltenham. Magnetic Observatory*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	*μ*	*μ*	*km.*	
1918. Aug. 15	.....	ePE...	12 37 35	3	.....	.....	.....	Sheets changed on North from 12 h. 47 m. 35 s. to 13 h. 05 m. 55 s. and on East from 13 h. 08 m. 40 s. to 13 h. 20 m. 23 s.
		ePN...	12 37 42	3	.....	.....	.....	
		eL_E...	12 58 ..	45	.....	.....	.....	
		eL_N...	13 20 ..	35	.....	.....	.....	
		ME....	13 41 53	18	320	.....	.....	
		M_N....	13 50 02	18	.....	150	.....	
		C_E....	14 01 ..	17	.....	.....	.....	
		C_N....	14 17 ..	16	.....	.....	.....	
		F_E....	14 34 ..	17	.....	.....	.....	
		F_N....	14 53 ..	16	.....	.....	.....	
15	.....	eP.....	17 52 50	3	.....	.....	.....	Possibly a few long waves on North about 1 hour later.
23	.....	eL_N...	7 39 ..	.....	.....	.....	.....	
		eL_E...	7 41 ..	.....	.....	.....	.....	
		M_E....	7 45 ..	17	10	.....	.....	
		M_N....	7 53 ..	16	.....	10	.....	
		C_N....	7 56 ..	16	.....	.....	.....	
		C_E....	7 57 ..	17	.....	.....	.....	

Massachusetts. *Cambridge. Harvard University Seismographic Station,* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

		V	T_0	ϵ
Instrumental constants..	E	80	23	0
	N	50	25	4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	*μ*	*μ*	*km.*	
1918. Aug. 5	.....	L_E....	2 35 ..	.....	.....	.....	.....	Minutes approximate. Clock contacts failed.
			2 50 ..					
8	.....	O.....	*10 .. ..*	.....	.....	.....	.....	E damped by magnet. N undamped.
		e_N?....	10 25 17	.....	.....	.....	.....	
		eL_N...	10 38 21	40	.....	.....	.....	
		L_N....	10 43 31	20	.....	.....	.....	
		L_N....	10 46 21	30	.....	.....	.....	
		L_N....	10 49 55	25	.....	.....	.....	
		L_E....	10 51 00	30	.....	.....	.....	
		L_N....	10 56 47	20	.....	.....	.....	Amplitude N increases.
			10 59 11	18	.....	.....	.....	
		F_N....	11 37 ..	.....	.....	.....	.....	
14	.....	L_E....	18 15 51	.....	.....	.....	.....	
		F.....	19 19 ..	.....	.....	.....	.....	
14	.....	e_E....	20 54 37	.....	.....	.....	.....	May not be seismic. Less definite on N–S.
		L_E....	20 54 53	8–13	.....	.....	.....	
		L.....	21 15 ..	.....	.....	.....	.....	
15	.....	O.....	*12 26 21*	.....	.....	.....	6426	Break in record changing sheets from 12h. 31m. to 13h. 03m., also E stylus tipped over from 14h. 56m. to 15h. 44m.
		P_N....	12 35 44	2	.....	.....	.....	
		i.....	12 37 56	.....	.....	.....	.....	
		i.....	12 38 07	2	.....	.....	.....	
		S_N....	12 42 43	20	.....	.....	.....	
		eL_N...	12 52 22	.....	.....	.....	.....	
		eM_N..	12 58 ..	22	.....	.....	.....	
		M_E....	13 28 ..	.....	.....	.....	.....	
		M_E....	13 30 30	28	.....	.....	.....	
		M_E....	13 38 30	30	.....	.....	.....	
		M_E....	13 46 36	16	.....	.....	.....	
		M_E....	13 54 ..	.....	.....	.....	.....	
		L_E....	14 04 30	.....	.....	.....	.....	
		L_E....	16 34 ..	24	.....	.....	.....	
			16 46 ..	.....	.....	.....	.....	
		F_E....	17 15 ..	.....	.....	.....	.....	
15	.....	O.....	*17 48 24?*	.....	.....	.....	9850?	
		S_E?....	18 10 50	8	.....	.....	.....	
		L_E....	18 30 18	26	.....	.....	.....	
		L_N....	18 30 54?	.....	.....	.....	.....	
		L_E....	18 34 30	30	.....	.....	.....	
		M_E?...	18 39 53	24	.....	.....	.....	
		L_E....	18 49 ..	20	.....	.....	.....	
		L_E....	18 57 ..	15	.....	.....	.....	
		F.....	19 52 ..	.....	.....	.....	.....	
21	.....	O.....	*4 11 54*	.....	.....	.....	225	Local shock near South Paris, Me. (lat. 44° 07′ 40″ N.; long. 70° 32′ 18″ W.). [See also noninstrumental reports, table 1].
		P_E....	4 12 28	.....	.....	.....	.....	
		M_E....	4 12 53	.....	.....	.....	.....	
		C.....	4 13 04	8	.....	.....	.....	
			4 13 45	.....	.....	.....	.....	
		F.....	4 14 08	.....	.....	.....	.....	
23	.....	O.....	*6 48 47?*	.....	.....	.....	10960?	Volcanos "Llama" (Llaimas) and Lanin (lat. 39° 45′ S.; long. 71° 30′ W.) reported in eruption. Lanin distant about 9,000 kms.
		eP_E?..	7 02 ..	.....	.....	.....	.....	
		e_E.....	7 06 13	.....	.....	.....	.....	
		S_E?....	7 14 14	20	.....	.....	.....	
		S_N?....	7 14 59	.....	.....	.....	.....	
		eL_E...	7 36 51	40	.....	.....	.....	
		L_E....	7 42 ..	20	.....	.....	.....	
		L_E....	7 48 54	15	.....	.....	.....	
		F.....	8 50 ..	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, August, 1918*—Continued.

Missouri. *Saint Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation: 12 feet of tough clay over limestone of Mississippi system, about 300 feet thick.

Instrument: Wiechert 80 kg. astatic, horizontal pendulum.

Instrumental constants.. V = 80, T_0 = 7, ε = 5:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Aug. 15	.....	$ePn_{...}$	12 38 48	.....	.....	.....	5,475	
		$eSn_{...}$	12 46 06	.....	.....	.....	.....	
		$eSe_{...}$	12 46 12	.....	.....	.....	.....	
		$eL_{...}$	12 52 06	.....	.....	.....	.....	
		$L_{...}$	12 55 48	.....	.....	.....	.....	
		$L_{...}$	13 19 ..	.....	.....	.....	.....	
		$M_{...}$	13 22 ..	25	.....	*4,000	.....	
		$L_{...}$	13 34 30	.....	.....	.....	.....	
		$L_{...}$	13 38 18	.....	.....	.....	.....	
		$L_{...}$	13 43 ..	.....	.....	.....	.....	
		$L_{...}$	13 46 48	.....	.....	.....	.....	
		$F_{...}$	15 02 ..	.....	.....	.....	.....	

* Trace amplitude.

New York. *Buffalo. Canisius College.* John A. Curtin, S. J.

Lat., 42° 53′ 02″ N.; long., 78° 52′ 40″ W. Elevation, 190.5 meters.

Instrument: Wiechert 80 kg. horizontal.

Instrumental constants.. V = 80, T_0 = 7, ε = 5:1

(Report for August, 1918, not received.)

New York. *Fordham. Fordham University.* Daniel H. Sullivan, S. J.

Lat., 40° 51′ 47″ N.; long., 73° 53′ 08″ W. Elevation, 29.3 meters.

Instrument: Wiechert, 80 kg.

Instrumental constants.. E: V = 72, T_0 = 5.0, ε = 0; N: V = 72, T_0 = 5.0, ε = 0

(Report for August, 1918, not received.)

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long. 76° 29′ 09″ W. Elevation, 242 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulums (mechanical registration).

Instrumental constants.. E: V = 13, T_0 = 22, ε = 4:1; N: V = 14, T_0 = 25, ε = 4:1

(Report for August, 1918, not received.)

Panama Canal Zone. *Balboa Heights.* Isthmian Canal Commission.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, 27.6 meters.

Instruments: Two Bosch-Omori, 100 kg.

Instrumental constants.. V = 35, T_0 = 20

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Aug. 1	.....	$P_{...}$	0 05 04	20	*200	*300	.....	Trace faint.
		F_N	0 12 00	.....	.....	.....	.....	
		F_E	0 13 00	.....	.....	.....	.....	
8	.....	$P_{...}$	10 02 44	.....	.....	.....	285	Direction uncertain.
		$L_{...}$	10 03 14	20	.....	.....	.....	
		M_E	10 03 18	.....	*500	.....	.....	
		M_N	10 03 20	.....	.....	*1,000	.....	
		F_E	10 05 24	.....	.....	.....	.....	
		F_N	10 05 34	.....	.....	.....	.....	
15	.....	P_E	12 38 11	.....	.....	.....	17,380	Do.
		P_N	12 38 14	.....	.....	.....	.....	
		S_N	12 49 10	.....	.....	.....	.....	
		S_E	12 51 01	.....	.....	.....	.....	
		L_N	13 30 10	20	.....	.....	.....	
		L_E	13 30 47	20	.....	.....	.....	
		M_E	13 40 17	.....	*5,000	.....	.....	
		M_N	13 40 40	.....	.....	*1,000	.....	
		F_E	14 30 00	.....	.....	.....	.....	
		F_N	14 31 00	.....	.....	.....	.....	

* Trace amplitude.

Panama Canal Zone. *Balboa Heights*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Aug. 27	.....	P_E	7 03 46	.....	.....	.....	764	Do.
		P_N	7 03 54	.....	.....	.....	.....	
		$L_{...}$	7 05 26	20	.....	.....	.....	
		$M_{...}$	7 05 40	.....	*600	*300	.....	
		F_E	7 13 00	.....	.....	.....	.....	
		F_N	7 15 00	.....	.....	.....	.....	

* Trace amplitude.

Porto Rico. *Vieques. Magnetic Observatory.* U. S. Coast and Geodetic Survey. W. M. Hill.

Lat., 18° 09′ N.; long., 65° 27′ W. Elevation, 19.8 meters.

Instruments: Two Bosch-Omori.

Instrumental constants.. E: V = 10, T_0 = 18; N: V = 10, T_0 = 20

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Aug. 8	.....	eL_N	10 59 ..	20	.....	.....	.....	Only a few L waves. E not recording.
		M_N	11 03 ..	20	.....	10	.....	
		C_N	11 12 ..	.....	.....	.....	.....	
15	.....	eP_E	12 39 03	5	.....	.....	.....	S and L uncertain.
		eP_N	12 39 05	5	.....	.....	.....	
		S_N	12 45 28	18	.....	.....	.....	
		S_E	12 45 40	17	.....	.....	.....	
		S_E	13 07 54	15	.....	.....	.....	
		S_N	13 08 06	.....	.....	.....	.....	
		M_{s1}	13 08 35	30	120	.....	.....	
		eL_E	13 22 15	40	.....	.....	.....	
		eL_N	13 33 00	30	.....	.....	.....	
		M_N	13 38 48	25	.....	60	.....	
		M_s2	13 39 15	27	70	.....	.....	
		C	13 51 ..	19	.....	.....	.....	
		F	14 45 ..	17	.....	.....	.....	
23	.....	eL	7 44 ..	19	.....	.....	.....	Only a few L waves.
		M_E	7 50 ..	.....	10	.....	.....	
		M_N	7 52 ..	.....	.....	10	.....	
		C_E	7 55 ..	.....	.....	.....	.....	

Vermont. *Northfield. U. S. Weather Bureau.* Wm. A. Shaw.

Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.

Instruments: Two Bosch-Omori, mechanical registration.

Instrumental constants.. E: V = 10, T_0 = 15; N: V = 10, T_0 = 16

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Aug. 8	.....	eL_E	10 50 ..	.....	.....	.....	.....	
		F	11 00 ..	.....	.....	.....	.....	
15	.....	e	12 38 30	.....	.....	.....	.....	
		eL	12 56 30	.....	.....	.....	.....	
		L	13 14 ..	30	.....	.....	.....	
		L	13 26 ..	24	.....	.....	.....	
		L	13 40 ..	18	.....	.....	.....	
		L	13 50 ..	16	.....	.....	.....	
		L	14 04 ..	14	.....	.....	.....	
		F	14 40 ..	.....	.....	.....	.....	

Canada. *Ottawa. Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.

Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 83 meters.

Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoyer 80k. vertical seismograph.

Instrumental constants.. V = 120, T_0 = 26

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Aug. 4	.....	e_N	16 21 ..	6	.....	.....	.....	
			16 42 ..	8	.....	.....	.....	
5	.....	e_N?	2 05 30	.....	.....	.....	.....	
		eL_N?	2 30 ..	12	.....	.....	.....	
		eL_N	2 39 30	16	.....	.....	.....	
		L	2 42 ..	16	.....	.....	.....	
		L	2 50 ..	16	.....	.....	.....	
		L_E	2 56 ..	16	.....	.....	.....	
		F	3 05 ..	.....	.....	.....	.....	
8	.....	O	*9 56 34*	.....	.....	.....	8,640	
		P	10 08 28	.....	.....	.....	.....	
		S	10 18 20	.....	.....	.....	.....	
		S_{Nrepl}	10 25 04	.....	.....	.....	.....	
		eL_E	10 36 ..	.....	.....	.....	.....	
		L	10 40 ..	30	.....	.....	.....	
		L	10 50 ..	24	.....	.....	.....	
		L	10 54 ..	20	.....	.....	.....	
		L	11 05 ..	17	.....	.....	.....	
		L	11 20 ..	16	.....	.....	.....	
		F	11 55 ..	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, August, 1918*—Continued.

Canada. *Ottawa. Dominion Astronomical Observatory*—Continued

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Aug. 15	.....	*O*.....	*12 27 32*	.....	.....	.....	6,300	F merges into next 'quake. Tremors lasted, faintly marked, for nearly five hours.
		P_N....	12 37 20	.....	.....	.....	.....	
		S_N....	12 45 12	.....	.....	.....	.....	
		L.....	12 56 ..	50	.....	.....	.....	
		L.....	13 17 ..	35	.....	.....	.....	
		L.....	13 30 ..	23	.....	.....	.....	
		L.....	13 51 ..	16	.....	.....	.....	
		L.....	14 10 ..	15	.....	.....	.....	
		L.....	14 35 ..	17	.....	.....	.....	
		L.....	14 55 ..	15	.....	.....	.....	
		F.....	.. .. ..	.....	.....	.....	.....	
15	.....	i.....	17 51 08	.....	.....	.....	.....	
		i.....	17 56 30	.....	.....	.....	.....	
		i_E....	18 08 ..	.....	.....	.....	.....	
		eL_E?..	18 21 ..	.....	.....	.....	.....	
		L_E....	18 30 ..	24	.....	.....	.....	
		L.....	18 40 ..	22	.....	.....	.....	
		L.....	18 45 ..	19	.....	.....	.....	
		F.....	19 10 ..	.....	.....	.....	.....	
17	.....	*O*.....	*6 53 27*	.....	.....	.....	7,300	
		P.....	7 04 11	.....	.....	.....	.....	
		S.....	7 12 55	.....	.....	.....	.....	
		eL_E...	7 25 ..	.....	.....	.....	.....	
		L.....	7 30 ..	24	.....	.....	.....	
		L.....	7 35 ..	18	.....	.....	.....	
		F.....	8 00 ..	.....	.....	.....	.....	
21	.....	*O*.....	*4 12 50*	.....	.....	.....	420	Reported from South Paris, Me. Record barely visible. Distance taken from the globe and used with P to get *O*.
		iP_N...	4 13 48	.....	.....	.....	.....	
		e.....	4 14 03	.....	.....	.....	.....	
		F.....	4 14 30	.....	.....	.....	.....	
22	.....	e_N....	{8 44 56 / 9 10 ..	.....	.....	.....	.....	Faint traces only on E–W. May not be seismic.
23	.....	i.....	6 56 13	.....	.....	.....	.....	
		e.....	7 02 21	.....	.....	.....	.....	
		e.....	7 06 23	.....	.....	.....	.....	
		i.....	7 12 54	.....	.....	.....	.....	
		eL.....	7 36 ..	18	.....	.....	.....	
		L.....	7 44 ..	16	.....	.....	.....	
		L.....	7 51 ..	15	.....	.....	.....	
		L.....	8 03 ..	14	.....	.....	.....	
		L.....	8 13 ..	14	.....	.....	.....	
		L_N....	8 24 ..	13	.....	.....	.....	
		L.....	8 44 ..	13	.....	.....	.....	
		F.....	9	.....	.....	.....	.....	

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North; in the meridian.

Instrumental constant..T_0 18. Pillar deviation, 1 mm. swing of boom=0.50″.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Aug. 4	.....	.....	.....	.....	.....	.....	.....	Light off. at time some stations record quake at 16h. 21m.
5	.....	L.....	2 42 00?	.....	.....	.....	.....	Microseisms mask phases.
8	.....	S_{repl}..	10 25 24	.....	.....	.....	.....	P and S not recorded.
		e.....	10 34 30	.....	.....	.....	.....	
		L.....	10 48 00	.....	.....	.....	.....	
		iL.....	10 49 06	.....	.....	.....	.....	
		L_E....	10 55 30	.....	.....	.....	.....	
		M.....	10 59 18	.....	*1,200	.....	.....	
		F.....	12 59 24?	.....	.....	.....	.....	
15	.....	P ?....	12 37 30	.....	.....	.....	.....	P may not be seismic.
		P_E....	12 39 48	.....	.....	.....	.....	
		i.....	12 45 42	.....	.....	.....	.....	Microseisms going on some time previous.
		iS.....	12 51 24	.....	.....	.....	.....	
		iS.....	12 55 12	.....	.....	.....	.....	
		L.....	12 58 00	.....	.....	.....	.....	
		L.....	13 02 06	.....	.....	.....	.....	Clear record.
		iL.....	13 27 18	.....	.....	.....	.....	
		iL.....	13 35 06	.....	.....	.....	.....	
		M.....	13 39 36	.....	*14,400	.....	.....	
		iL.....	13 50 30	.....	.....	.....	.....	
		iL.....	13 55 36	.....	.....	.....	.....	
		L.....	14 02 18	.....	.....	.....	.....	
		F.....	.....	.....	.....	.....	.....	Merged in next quake.

*Trace amplitude.

Canada. *Toronto. Dominion Meteorological Service*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Aug. 15	.....	L.....	17 51 54	.....	.....	.....	.....	
		L.....	18 13 00	.....	.....	.....	.....	
		L.....	18 57 00	.....	.....	.....	.....	
		M.....	18 59 06	.....	*300	.....	.....	
		F.....	20706 06	.....	.....	.....	.....	
16	.....	L.....	9 20 42	.....	*50	.....	.....	Doubtful as to being seismic.
17	.....	L.....	7 31 36	.....	.....	.....	.....	F lost im microseisms.
		eL.....	7 40 06	.....	.....	.....	.....	
		M.....	7 41 42	.....	*200	.....	.....	
		F.....	.....	.....	.....	.....	.....	
21	.....	L.....	4 14 24	.....	.....	.....	.....	Doubtful as to being seismic. F lost in microseisms.
		M.....	4 14 36	.....	.....	.....	.....	
		F.....	.....	.....	.....	.....	.....	
22	.....	L.....	8 42 18	.....	*50	.....	.....	Doubtful as to being seismic.
		F.....	8 47 36	.....	.....	.....	.....	
23	.....	P.....	7 01 12?	.....	.....	.....	.....	Microseisms at 6h. 55m. 06s.
		iP.....	7 05 54	.....	.....	.....	.....	
		S.....	7 12 54	.....	.....	.....	.....	
		eL.....	7 17 06	.....	.....	.....	.....	
		eL.....	7 35 36	.....	.....	.....	.....	
		eL.....	7 37 48	.....	.....	.....	.....	
		M.....	7 47 24	.....	*2,300	.....	.....	
		L.....	8 08 12	.....	.....	.....	.....	
		L.....	8 57 36	.....	.....	.....	.....	
		F.....	10 10 00?	.....	.....	.....	.....	

*Trace amplitude.

Canada. *Victoria, B. C. Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instrument: Wiechert, vertical; Milne horizontal pendulum, North. In the meridian.

Instrumental constant..T_0 18. Pillar deviation, 1 mm., swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Aug. 5	.....	P.....	2 12 58?	.....	.....	.....	5,200	
		S.....	2 19 51	.....	.....	.....	.....	
		L.....	2 29 01	.....	.....	.....	.....	
		M.....	2 35 35	.....	*300	.....	.....	
		F.....	3 01 39?	.....	.....	.....	.....	
8	.....	P.....	10 11 45	.....	.....	.....	4,120	
		S.....	10 17 39	.....	.....	.....	.....	
		L.....	10 19 57	.....	.....	.....	.....	
		M.....	10 41 45	.....	*1,500	.....	.....	
		F.....	12 27 29	.....	.....	.....	.....	
			VERTICAL.			*Az*		
		P.....	*10 11 54*	*6*	.....	.....	*4,330*	
		S.....	*10 17 39*	.....	.....	.....	.....	
		L.....	*10 29 30*	*30*	.....	.....	.....	
		M.....	*10 34 30*	*24*	.....	*4*	.....	
15	.....	P.....	12 32 18	.....	.....	.....	10,440	Probably in vicinity of Malay Archipelago.
		S.....	12 43 36	.....	.....	.....	.....	
		L.....	12 55 24	.....	.....	.....	.....	
		or.....	12 58 21	.....	.....	.....	.....	
		M.....	13 23 27	.....	*9,000	.....	.....	
		F.....	17 10 10	.....	.....	.....	.....	
			VERTICAL.			*Az*		
		P.....	*12 32 18*	*3*	.....	.....	*11,770*	*Probably in vicinity of Malay Archipelago.*
		S.....	*12 44 30*	*8–10*	.....	.....	.....	
		L.....	*13 04 30*	*24*	.....	.....	.....	
		M.....	*13 06 18*	*30*	.....	*18*	.....	
		F.....	*? ? ?*	.....	.....	.....	.....	
15	.....	P.....	17 55 54	.....	.....	.....	9,890	May be from above area.
		S.....	18 06 47	.....	.....	.....	.....	
		L.....	18 17 03	.....	.....	.....	.....	
		M.....	18 42 37	.....	*400	.....	.....	
		F.....	19 11 09?	.....	.....	.....	.....	
16	.....	L or S..	9 22 34	.....	.....	.....	.....	
		M.....	9 38 47	.....	*100	.....	.....	
17	.....	L.....	7 43 40	.....	.....	.....	.....	
		M.....	7 45 28	.....	*100	.....	.....	
		F.....	7 47 20	.....	.....	.....	.....	
			VERTICAL.			*Az*		
22	.....	*Local*..	*15 21 35*	.....	.....	*1*	.....	*Lasted 1 second, preceded by a rumbling noise. Felt at Victoria Observatory and in rocky parts of city, causing articles to rattle. Probably under Strait of De Fuca.*
23	.....	P.....	6 59 31	.....	.....	.....	4,140	Extreme western part of Aleutian Islands.?
		S.....	7 05 26	.....	.....	.....	.....	
		L.....	7 15 45	.....	.....	.....	.....	
		M.....	7 27 06	.....	*4,000	.....	.....	Vertical out of order.
		F.....	9 36 24	.....	.....	.....	.....	

*Trace amplitude.

TABLE 3.—*Late seismological reports (instrumental).*

Arizona. *Tucson. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat., 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.
Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: {E V = 10, T_0 = 13.6; N V = 10, T_0 = 18.6}

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
July 3	.....	eP_E...	7 15 49	7	.....	.....	.....	Very faint. Nothing on N.
		eL_E...	7 39 ..	.....	.....	.....	.....	
		M_E....	7 59 ..	17	10	.....	.....	
		F_E....	9 23 ..	.....	.....	.....	.....	
8	.....	e_E?....	10 43 12	5	.....	.....	.....	
		eL_E...	11 17 50	40	.....	.....	.....	
		eL_N...	11 22 37	25	.....	.....	.....	
		M_E....	11 26 17	25	10	.....	.....	
		C_N....	11 37 ..	.....	.....	.....	.....	
		F_E....	12 08 ..	17	.....	.....	.....	
14	.....	eP_E...	18 21 00	4	.....	.....	.....	Probably local.
		eP_N...	18 21 05	2	.....	.....	.....	
		M.....	18 22 45	5	10	10	.....	
		F.....	18 26 ..	.....	.....	.....	.....	
15	.....	P.....	0 26 42	4	.....	.....	.....	
		S_N?...	0 29 37	4	.....	.....	.....	
		S_E ...	0 29 41	4	.....	.....	.....	
		L_E....	0 30 47	18	.....	.....	.....	
		L_N....	0 30 53	18	.....	.....	.....	
		M_N....	0 32 30	12	.....	340	.....	
		M_E....	0 33 12	13	360	.....	.....	
		C_N....	0 37 ..	10	.....	.....	.....	
		C_E....	0 40 00	9	.....	.....	.....	
		F_N....	1 18 ..	8	.....	.....	.....	
		F_E....	1 25 ..	8	.....	.....	.....	
21	.....	eP_E...	6 27 15	.....	.....	.....	.....	Phases very doubtful. Nothing on N.
		eS_E...	6 35 50	.....	.....	.....	.....	
		eL_E...	6 54 35	25	.....	.....	.....	
		M_E....	7 00 35	19	20	.....	.....	
		C_E....	7 16 ..	16	.....	.....	.....	
		F_E....	7 53 ..	16	.....	.....	.....	
31	.....	eL_E...	14 55 ..	.....	.....	.....	.....	Only a few long waves.
		eL_N...	14 57 ..	.....	.....	.....	.....	
		M_N....	15 00 ..	18	.....	10	.....	
		M_E....	15 10 ..	12	10	.....	.....	
		C.....	15 15 ..	.....	.....	.....	.....	
		F.....	.. .. ..	.....	.....	.....	.....	

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neumann.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association, E–W component.

Instrumental constant....T_0

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
July 1	.....	P.....	6 19 12	.....	.....	.....	.....	Period of pendulum on July 1, 29.4 seconds, sensitiveness 0.28″; period of pendulum after July 1, 25.5 seconds sensitiveness 0.46″; Pendulum readjusted on July 23 to a period of 18.2 seconds, sensitiveness 1.11″.
		S.....	6 29 18	.....	.....	.....	.....	
		L.....	6 41 54	30	.....	.....	.....	
		M.....	6 44 00	.....	*1500	.....	.....	
		C.....	6 47 35	.....	.....	.....	.....	
		F.....	7 39 ..	.....	.....	.....	.....	
3	.....	P.....	7 02 30	.....	.....	.....	.....	
		S.....	7 11 12	.....	.....	.....	.....	
		L.....	7 23 24	30	.....	.....	.....	
		M.....	7 26 06	.....	*3300	.....	.....	
		C.....	7 55 ..	.....	.....	.....	.....	
		F.....	10 47 ..	.....	.....	.....	.....	

*Trace amplitude.

Hawaii. *Honolulu. Magnetic Observatory*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Aug. 6	.....	eP.....	20 29 00	.....	.....	.....	.....	
		eL.....	20 37 30	30	.....	.....	.....	
		M.....	20 40 30	.....	*400	.....	.....	
		C.....	20 44 00	.....	.....	.....	.....	
		F.....	20 51 ..	.....	.....	.....	.....	
8	.....	e.....	5 54 12	.....	.....	.....	.....	Tremors and waves very irregular, about 1 1mm. amplitude except at M, which is well marked. Probably only part of this disturbance is seismic.
		M.....	11 18 00	.....	*6500	.....	.....	
		C.....	11 22 ..	.....	.....	.....	.....	
		F.....	19 30 ..	.....	.....	.....	.....	
9	.....	eP.....	2 17 48	.....	.....	.....	.....	
		eL.....	2 31 00	.....	.....	.....	.....	
		M.....	2 33 00	28	*100	.....	.....	
		F.....	3 45 ..	.....	.....	.....	.....	
11	.....	e.....	22 07 00	.....	.....	.....	.....	
		M.....	22 09 00	23	*100	.....	.....	
		F.....	22 16 ..	.....	.....	.....	.....	
15	.....	eP.....	0 30 00	.....	.....	.....	.....	Recorded on variometer.
		L.....	0 37 06	.....	.....	.....	.....	
		M.....	0 40 00	.....	*1000	.....	.....	
		C.....	0 42 36	.....	.....	.....	.....	
		F.....	1 54 ..	.....	.....	.....	.....	
21	.....	P.....	6 18 06	.....	.....	.....	.....	
		S.....	6 26 18	.....	.....	.....	.....	
		eL.....	6 33 00	.....	.....	.....	.....	
		M.....	6 37 00	.....	*3100	.....	.....	
		C.....	6 44 ..	.....	.....	.....	.....	
		F.....	8 48 ..	.....	.....	.....	.....	
21	.....	eP.....	10 01 12	.....	.....	.....	.....	Probably a recurrence of the preceding 'quake.
		eL.....	10 10 30	.....	.....	.....	.....	
		M.....	10 12 00	.....	*500	.....	.....	
		F.....	10 49 ..	.....	.....	.....	.....	
23	.....	eP.....	13 39 24	.....	.....	.....	.....	Pendulum adjusted just after this.
		eL.....	13 47 00	29	.....	.....	.....	
		M.....	13 52 00	.....	*500	.....	.....	
		C.....	13 56 ..	.....	.....	.....	.....	
		F.....	14 18 ..	.....	.....	.....	.....	
29	.....	eP.....	11 32 06	.....	.....	.....	.....	
		eL.....	11 38 00	.....	.....	.....	.....	
		M.....	11 45 18	.....	*600	.....	.....	
		C.....	11 49 ..	.....	.....	.....	.....	
		F.....	12 30 ..	.....	.....	.....	.....	
29	.....	eP.....	17 00 42	.....	.....	.....	.....	
		S.....	17 09 00	.....	.....	.....	.....	
		eL.....	17 19 00	.....	.....	.....	.....	
		M.....	17 34 12	20	*1000	.....	.....	
		C.....	17 42 ..	.....	.....	.....	.....	
		F.....	19 30 ..	.....	.....	.....	.....	
31	.....	P.....	14 48 30	.....	.....	.....	.....	
		S.....	14 56 54	.....	.....	.....	.....	
		L.....	15 09 12	27	.....	.....	.....	
		M.....	15 13 48	.....	*400	.....	.....	
		C.....	15 18 ..	.....	.....	.....	.....	
		F.....	16 48 ..	.....	.....	.....	.....	
31	.....	P.....	22 14 00	.....	.....	.....	.....	
		L.....	22 22 00	19	.....	.....	.....	
		M.....	22 28 30	.....	*500	.....	.....	
		F.....	23 28 ..	.....	.....	.....	.....	

*Trace amplitude.

SEISMOLOGICAL DISPATCHES.[1]

There were no press reports of seismological or vulcanological disturbances during August, 1918.

[1] Reported by the organization indicated and collected by the seismological station at Georgetown University, Washington, D. C.

SECTION VI.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

[Courty, Fernand.]
Observation des orages de 1917 dans les départements de la Gironde et partie de la Dordogne. Expérience des paragrêles élextriques. Résultats déduits des observations de 1912 à 1917. Bordeaux. 1918. 51 p. incl. tables. fold. map. 24½ cm. (Extrait du Bulletin de Commission météorologique de la Gironde, année 1917.) [The author of this report finds that there has been no perceptible difference in the character of thunderstorms and their attendant phenomena, in the district under discussion, since the installation of numerous hail-rods therein. Records are presented showing the occurrence of many severe hailstorms near the various hail-rod stations. The report, though not final, is decidedly unfavorable to claims made for these devices.]

Curtis, W. Parkinson.
Phenological report on first appearance of birds, insects, etc., and first flowering of plants in Dorset for 1916. Dorchester. 1917. cover-title, 100 p. incl. tables. 31 cm. (From "Proceedings" Dorset natural history and antiquarian field club, vol. 38, p. 133, 1917.)

Diem, K.
Regenwaarnemingen op Sumatra's oostkust, de oostkust van Atjeh en in Tapanoeli in 1917 . . . Medan. 1918. p. xxiv-xliii, incl. tables. 24½ cm. At head of title: Mededeelingen van het Deli proefstation te Medan, Sumatra. Jaargang 10. Bladz. 21–44. 10de aflevering . . .

Doublet, É[douard Lucien].
Les études de physique du globe aux États-Unis. Bordeaux. 1918. 30 p. 24½ cm.

Eredia, Filippo.
Le medie normali della quantità di pioggia in Italia. Roma. 1918. 8 p. incl. tables. 26½ cm. (Estratto dal Giornale del Genio civile, anno 56, 1918.)
La variazione diurna della temperatura a Catania e a Messina. cover-title. 5 p. incl. tables. charts. 23½ cm. (Dal Bollettino dell'Accademia gioenia di scienze naturali in Catania fasc. 44, Luglio, 1918.)

Fontseré [y Riba], E[duardo].
Treballs de l'estació aerològica de Barcelona. Serie 2. Any 1915. Barcelona. 1917. 83 p. incl. charts. tables. 28 cm. At head of title: Publicacions de l'Institut de ciencies.

Galli, Ignazio.
Di altri fulmini globulari osservati in Italia dal 1915 al 1917. Nota 19. 19 p. 29½ cm. (Estratto dagli Atti della Pontificia accademia romana dei Nuovi Lincei. Sessione 5a del 21 aprile 1918.)

Gauthier, H.
La température en Chine et à quelques stations voisines d'après des observations quotidiennes. Changhai. 1918. xlviii, 794 p. in 3 v. incl. map. charts. tables. 31 cm. At head of title: Observatoire de Zikawei.

Great Britain. Meteorological office.
Cloud forms according to the international classification. The definitions and descriptions approved by the International meteorological committee in 1910. With an atlas of photographs of clouds selected from the collection of Mr. G. A. Clarke of the Observatory, Aberdeen . . . London. 1918. 10 p. Plates. 24 cm. M. O. 233.

Linney, Charles E.
Climate in relation to crop adaptation in New Mexico, by Charles E. Linney and Fabian Garcia. Albuquerque. 1918. 132 p. map. charts. tables. 23 cm. At head of title: Bulletin no. 113. June, 1918. New Mexico college of agriculture and mechanic arts. Agricultural experiment station, State college, N. M. In cooperation with United States Department of agriculture, Weather bureau.

McGlashan, H[arry] D.
Southern California floods of January, 1916, by H. D. McGlashan and F. C. Ebert. Prepared in cooperation with the state of California. Washington. 1918. 80 p. plates. tables. 23 cm. fold. map in envelope at back. At head of title: Department of the interior . . . U. S. Geological survey . . . Water-supply paper 426.

Mawson, D[ouglas].
Auroral observations at the Cape Royds station, Antarctica. British antarctic expedition, 1908. cover-title, fold. map. graphs (part. fold.) 22 cm. (From "Transactions of the Royal society of South Australia," vol. 40, 1916.)

Port-au-Prince (Haiti) Séminaire-collège St-Martial. Observatoire météorologique.
Bulletin annuel. Année 1917. [Port-au-Prince] 1918. 131 p., l. incl. tables. 31 cm.

Southport. Fernley observatory.
. . . Report and results of observations for the year 1917, with an appendix, by Joseph Baxendell. Southport. 1918. 31 p. incl. tables. 25 cm.

Stok, J[ohannes] P[aulus] van der.
Bijdrage tot de Kennis van het klimaat van Nederland. De temperatuur van lucht en zee. [De Bilt] 1918. tables. 25 cm. (Overgedrukt uit het "Tidschrift van het K. Nederlandsch aardrijkskundig genootschap, 2e Ser. dl. 35, 1918, Afl. 3," p. 348–367.)

Upsala. Université. Observatoire météorologique.
Bulletin mensuel. Vol. 49. Année 1917 . . . Upsala. 1917–1918. 74 p. incl. tables. 34 cm.

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Review. The titles selected are of papers and other communications bearing on meteorology and cognate branches of sicence. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

Aerial age. New York. v. 8. 1918.
Cave, C. J. P. Some meteorological conditions which increase the danger of flying. p. 1322–1323; 64. (Sept. 16, 23.)

Aeronautical journal. London. v. 22. July, 1918.
Wind at various heights. p. 250. [Abstract from Oesterr. Flug-Zeitschrift, Feb.–Mar., 1918. [Analyzes data from Vienna, 1911–1914.]

Aérophile, Paris. 26 année. 1–15 juin, 1918.
Frantzen, Lucien. Cerfs-volants météorologiques. p. 169–170.

American climatological and clinical association. Transactions. Philadelphia. v. 33. 1917.
Hinsdale, Guy. The American Virgin islands, our newest West India possessions; their climate and topography. p. 25–30. [Climatic data almost nil.]

Astrophysical journal. Chicago. v. 48. September, 1918.
Sleator, W. W. The absorption of near infra-red radiation by water vapor. p. 125–143.

British astronomical association. Journal. London. v. 28. March, 1918.
Metcalfe, H. The green flash. p. 157–159.

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Ruhling, George H. Record rainfall at Highland Park [Michigan.] p. 445–446. (Sept. 5.)
June floods cause damage to bridges in Iowa. Serious interference with highway traffic results from undermining of piers, fall of spans and washouts in roads. p. 500–501. (Sept. 12.)

Franklin institute. Journal. Philadelphia. v. 186. September, 1918.
Humphreys, W[illiam] J[ackson.] Physics of the air. p. 341–370. (Continuation.)

Journal of geography. New York. v. 17. September, 1918.
Loft, Genivera. The Gulf stream and the North Atlantic drift. p. 8–17. [Effects of the Gulf stream on climate. p. 12–16.]

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Bancroft, Wilder D. Some properties of fog. p. 309–336.

Medical times. New York. v. 46. September, 1918.
Redway, Jacques W. Hot spells and cold waves. p. 228–230.

Meteorological society of Japan. Journal. Tôkyo. 37th year. August, 1918,
Sigetomi, Kôsaku. Abnormal change of air temperature at Tôkyo and Sinagawa. p. 49–54.

Nature. London. v. 101. July 4, 1918.
Sampson, R. A. The meteorological unit of pressure. p. 353. [Favorable review of Prof. Marvin's proposals as to the bar, etc.]

Royal meteorological society. Quarterly journal. London. v. 44. July, 1918.
Owens, J. S. The measurement of atmospheric pollution. p. 149–170.
Bilham, E. G. On the variation of underground water-level near a tidal river. p. 171–189.
Brooks, C. E. P. The meteorology of Port Moresby, British New Guinea. 1891 to 1916. p. 217–220.
Walker, Gilbert T., & Dines, W. H. Correlation in seasonal variations of weather. p. 223–225.
Marvin, Charles F. Absolute units for pressure. p. 225–230.

Science. New York. v. 48. August, 30, 1918.
Harper, Roland M. A new seasonal precipitation factor of interest to geographers and agriculturists. p. 208–211.

Scientific American supplement. New York. v. 86. 1918.
Fabry, Charles. The blue of the sky and other phenomena of molecular diffusion. p. 174–176. (Sept. 14.)
Recent observations on the solar corona. p. 199. (Sept. 28.) [Abstract of article by Maurer.]

Scientific monthly. New York. v. 7. October, 1918.
Ward, Robert DeC[ourcy]. Weather controls over the fighting during the summer of 1918. p. 289–298.

Académie d'agriculture. Comptes rendus. Paris. no. 27. 24 juillet, 1918.
Vidal, E. Les tirs de fusées contre les orages chargées de grêle. p. 756–758.

Académie des sciences. Comptes rendus. Paris. Tome 167. 26 août, 1918.
Reboul, G. Influence du rayon de courbure des corps sur la formation du givre. p. 331–333.
Collignon, Maurice. Sur la propagation du son du canon à grande distance. Périodicité annuelle. 333–335.

Astronomie. Paris. 32 année. Avril, 1918.
Guillaume, C[harles] Ed. La visibilité des ondes sonores. p. 138–139.

Hemel en dampkring. Den Haag. 16 jaarg. Juli 1918.
Visser, S. W. Kleuren van halo's. p. 35–38. [Gives statistics of number of spectral colors seen in halos during a period of five years.]

SECTION VII.—THE WEATHER AND DATA FOR THE MONTH.

WEATHER OF AUGUST, 1918.

P. C. DAY, Climatologist and Chief of Division.

[Dated: Climatological Division, Washington, Oct. 3, 1918.]

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing direction of the winds for August, 1918, are graphically shown on Chart VII; while the means at the several stations, with the departures from the normal, are shown in Tables I and III.

At the beginning of August the pressure was below normal in the upper Lake region and over the Pacific Coast States. Elsewhere it was generally normal or slightly above. During the first decade there was no active cyclonic or anticyclonic movement, but pressure was relatively low over central and northern districts east of the Rocky Mountains and somewhat above normal in the Southeast. West of the Rocky Mountains pressure was on the whole near the normal, relatively high in northern districts and relatively low in southern districts. Early in the second decade higher pressure overspread most eastern sections and, except for short periods, pressure remained relatively high almost continuously throughout the decade, particularly in the northeastern districts. Here at the close of the decade it was more than half an inch above the normal, and effectually blocked the eastward progress of disturbances from the West. In the Middle West the pressure was generally below the normal during this decade, and in the far West it was near the normal. The high pressure that prevailed over northeastern districts at the beginning of the third decade gradually settled southward, and during most of the decade the pressure was normal or above over the southeastern States. Along the northern border east of the Rocky Mountains pressure was mostly below normal, several LOWS with their centers north of the United States having moved eastward during the decade. In other districts there was little storm activity and pressure remained generally close to the normal.

For the month as a whole the barometric pressure averaged slightly below the normal over a narrow strip from north-central Texas to the Canadian border, but elsewhere it was above the seasonal average, although departures were comparatively small. Over the maritime districts of Canada the monthly pressure was considerably above normal, and in the Northwest Provinces it was about the same amount below.

Due to the absence of important atmospheric disturbances there were few high winds, and the prevailing directions were not pronounced, although east of the Rocky Mountains they were mainly from southerly points. In the districts west of the Rocky Mountains they were mostly from some westerly point, particularly where the directions were not influenced by local topography.

TEMPERATURE.

The month opened with cool weather in the central and northern districts east of the Mississippi River, but it continued warm in the Plains region and the Southwest. The warm area moved slowly eastward with increasing intensity, and by the middle of the first decade covered the great central valleys. At points in Nebraska, Iowa, and adjoining States the maximum temperatures passed above the highest previously reported. During the 6th and 7th the hot wave overspread the Atlantic Coast States from the Carolinas to southern New England, and the highest temperatures of record were experienced at many points. At Atlantic City the maximum temperature of 104° was 5 degrees above the maximum record at that station for any month in the past 45 years.[1]

In the Gulf region, the extreme Northeast, and west of the Rocky Mountains, moderate temperature prevailed during this period, and cool weather set in over the far Northwest about the middle of the decade. During the next few days this cool area moved southeastward to the upper Lakes region, but the decade closed with the temperature continuing above the seasonal average generally, except along the New England coast and over the northern Rocky Mountain districts.

The first few days of the second decade were warm in the Eastern States, but there was a sharp fall in temperature in the upper Lake region and the upper Mississippi Valley, and it was somewhat cooler in the Missouri Valley and the southern Plains region. About the middle of the month cooler weather prevailed from the Ohio Valley and the Middle Atlantic States northward, but high temperatures continued in the east Gulf States, the maximum readings on the 15th and 16th exceeding the previous high record for August at several points in that area. Cool weather for the season prevailed during the next few days in the Northeastern States and also in the Central Plateau districts, and at the close of the decade it continued cool in the Lake region and the Atlantic coast district, but higher temperature prevailed in the central and southern Plains States. During the early part of the third decade it was generally warm east of the Mississippi River except in the Southeast, where some localities, particularly in Georgia, experienced on the morning of the 22d the lowest August temperature of record. Cool weather also set in about this time over the Rocky Mountain and northern Plains States. Shortly after the middle of the decade there was a decided rise in temperature in the upper Mississippi Valley and the Lake region, but over the far Northwest the temperature fell to below the seasonal average. Cooler weather prevailed in the upper Mississippi Valley during the last few days of the month, and there was a decided fall in temperature in the central Plains. At a number of points in the north Pacific States the maximum readings near the end of the month were higher than any heretofore recorded during August.

For the month as a whole temperature was below the normal in the extreme Northeast, and from the Rocky Mountains westward to the Pacific, except over small areas in the western portions of Washington and Oregon and in central and southwestern California. Elsewhere the temperature was above the seasonal average, the excess ranging from 3 degrees to 6 degrees a day from the central Plains States eastward nearly to the Atlantic coast. An average deficiency of about 3 degrees a day occurred throughout the greater part of the Plateau re-

[1] For a detailed description of this intensely hot spell, see pp. 361, this REVIEW.

gion, and from 3 degrees to 6 degrees a day along the immediate Pacific coast from northern California to Washington.

PRECIPITATION.

At the beginning of the month there were local rains in the upper Lakes and Plateau regions, and there were showers in the Southeast. Elsewhere generally fair weather prevailed. About the middle of the first decade local rains and thundershowers occurred from the central Rocky Mountain States northeastward to the Upper Lakes, in eastern and extreme western Texas, and in portions of New Mexico and Montana. During the remainder of the decade showers occurred in many localities from the Rocky Mountains eastward, with heavy falls in the Panhandle of Texas. On the 6th a severe tropical storm caused the loss of several lives and destroyed much property in southwestern Louisiana, but after passing inland its force rapidly dissipated.

The first few days of the second decade brought some heavy rains along the east Gulf coast, and a number of thunderstorms that occurred in widely separated localities from the Rocky Mountains eastward were accompanied by heavy rains at points in Pennsylvania, Ohio, and Minnesota. About the middle of the month showers occurred from the Ohio and upper Mississippi Valleys westward nearly to the Pacific, while light local rains fell in Texas and Louisiana, and from Maryland northward. The falls were heavy locally in the upper Mississippi Valley. During the next few days showers were quite general from the central and lower Mississippi Valley eastward, and also in the far Northwest, and the decade closed with more or less rain over the Gulf and South Atlantic States, the falls being heavy in the lower Mississippi Valley. At the same time local rains occurred in the northern Plains States and the upper Missouri Valley. During the first few days of the third decade rain fell in some sections of the Gulf States and in many localities from the Lake region westward to the Rocky Mountains, the amounts being large at points in Minnesota and North Dakota. Generous to heavy showers were received also over considerable areas from Kansas and Missouri southward. About the middle of the decade rain occurred locally in the districts from the Rocky Mountains eastward, and was generally light except in eastern North Carolina and at points in the Ohio and middle Mississippi Valleys and in Texas. During the latter part of the month rain fell over large areas east of the Mississippi River, and also in the lower Missouri Valley, Arkansas, and the eastern portions of Kansas and Oklahoma, the falls being heavy in portions of the east Gulf States and the Ohio Valley.

For August as a whole the precipitation was heavy in the coastal portion of the central and eastern Gulf States, in eastern North Carolina, and in portions of the central and upper Mississippi Valley and Middle Atlantic States. Elsewhere over the eastern half of the country rainfall was generally moderate to light. From the Rocky Mountains westward the rainfall was light, except over a few limited areas, while in small portions of Utah and Nevada and over much of central California no precipitation occurred.

RELATIVE HUMIDITY.

The continued hot weather in the southern Plains region and thence northeastward and eastward was reflected in the relative humidity, which was below normal over nearly all the eastern two-thirds of the country, the deficiency amounting to from 10 to 20 per cent in the middle and southern Great Plains. There was a slight deficiency along the immediate Pacific coast, but in the Rocky Mountains and Plateau States the relative humidity was somewhat higher than normal.

GENERAL SUMMARY.

For August as a whole the weather was generally favorable for farm work. Corn as a rule made good progress in most northern and eastern sections, but in the more central and southern districts the intense heat and dry weather caused much deterioration. During the early part of the month the weather was generally favorable for cotton in the eastern portion of the belt, but as a whole it was too dry in most sections until near the end of the month, and the general growth of cotton was unsatisfactory. The harvesting and thrashing of spring wheat progressed favorably and the crop was generally good. Oats and other small grains were likewise harvested with satisfactory yields. The weather was unfavorable for potatoes and truck crops in the Central and Southwestern States, but elsewhere these crops generally made good progress. Meadows and pastures as a rule were in good condition, except in the more central sections, where they were unfavorably affected by the dry weather and high temperatures. Fruits made satisfactory progress and the outlook was good in the main producing centers.

SEVERE LOCAL STORMS.

The following note of a severe storm has been extracted from the official Weather Bureau report:

Minnesota.—The most destructive tornado that has visited the State in many years struck Tyler, Lincoln County, on August 21, 1918, at 9:20 p. m., demolished most of the business portion of the town, and caused the loss of 36 lives and nearly a million dollars' worth of property.

Average accumulated departures for August, 1918.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	In.	In.	In.	0–10.		P. ct.	
New England	67.8	+0.8	− 8.5	3.09	−0.80	− 5.30	4.9	−0.2	75	− 6
Middle Atlantic	75.6	+2.8	− 0.6	2.61	−1.90	− 4.10	4.6	−0.5	74	− 3
South Atlantic	79.6	+1.8	+ 4.5	3.91	−2.20	−11.20	4.3	−0.9	78	− 4
Florida Peninsula	82.8	+0.4	+ 4.0	3.80	−3.20	−13.40	5.2	−0.2	75	− 4
East Gulf	80.5	+1.3	+ 7.3	6.21	+1.30	− 4.80	5.0	−0.1	76	− 4
West Gulf	83.8	+2.8	+ 7.8	1.82	−1.20	− 8.10	4.0	+0.1	78	+ 3
Ohio Valley and Tennessee	79.0	+4.6	+ 0.3	3.45	0.00	− 4.10	4.8	+0.3	69	− 4
Lower Lakes	72.8	+3.1	− 3.4	2.14	−0.90	− 3.30	4.6	0.0	68	− 4
Upper Lakes	68.7	+2.4	− 5.6	1.98	−1.00	− 2.80	4.8	0.0	73	− 3
North Dakota	67.4	+0.4	+11.9	3.36	+1.10	− 2.10	4.0	−0.2	68	+ 1
Upper Mississippi Valley	77.0	+4.1	+ 3.3	4.01	+0.80	− 1.70	4.9	+0.6	69	− 2
Missouri Valley	78.6	+4.8	+14.7	2.65	−0.70	− 5.10	4.0	−0.2	62	− 5
Northern slope	65.8	−0.9	+ 5.9	1.42	+0.10	+ 1.00	4.2	+0.3	58	+ 3
Middle slope	79.5	+4.2	+11.5	2.15	−0.30	− 1.60	3.9	0.0	51	−11
Southern slope	81.5	+2.4	+13.7	1.76	−0.90	− 5.30	2.9	−0.9	52	−11
Southern Plateau	75.1	−2.2	− 0.8	1.51	+0.20	− 0.10	3.2	−0.4	50	+ 6
Middle Plateau	69.5	−2.1	+ 1.6	0.62	−0.10	− 1.20	2.8	−0.2	40	+ 1
Northern Plateau	66.8	−3.6	+10.2	0.75	+0.40	− 1.20	4.2	+1.5	48	+ 6
North Pacific	62.2	+0.3	+ 6.9	1.74	+1.00	− 2.30	5.3	+0.7	76	0
Middle Pacific	66.0	+1.1	+ 4.4	0.06	0.00	− 6.50	0.3	−3.0	58	− 4
South Pacific	71.7	+1.2	+13.5	0.04	0.00	+ 2.50	2.5	−0.1	65	0

WEATHER CONDITIONS OVER THE NORTH ATLANTIC OCEAN DURING AUGUST, 1917.

The data presented are for August, 1917, and comparison and study of the same should be in connection with those appearing in the Review for that month.

Chart IX (XLVI—71) shows for August, 1917, the principal storm tracks and the averages of pressure, air temperature, water-surface temperature, and prevailing direction of the wind at 7 a. m. 75th Meridian Time (Greenwich mean noon).

PRESSURE.

The distribution of the average pressure for the month presented few unusual features, as the North Atlantic or Azores HIGH was practically normal in position, although of slightly greater intensity than usual. The Icelandic LOW was well developed, the center being near the north coast of Scotland, where the mean pressure was 29.62 inches, which is considerably below the normal.

Over the western division of the ocean the pressure changes from day to day were not unusually great, while in the waters adjacent to the coast of Europe the variations and extremes were comparatively large, as shown in the following table, which gives for a number of 5-degree squares the mean pressure for each of the three decades of the month, as well as the highest and lowest individual readings reported within the respective squares.

Pressure over North Atlantic Ocean during August, 1917, by 5-degree squares.

Position of 5-degree squares.		Decade means.			Extremes.			
					Highest.		Lowest.	
Latitude.	Longitude.	I	II	III *	Pressure.	Date.	Pressure.	Date.
°	°	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*August.*	*Inches.*	*August.*
60–65 N	20–25 W	29.85	29.71	29.66	30.10	2	29.40	23
60–65 N	0– 5 E	29.96	29.63	29.52	30.20	4	29.20	29
55–60 N	35–40 W	30.01	29.98	29.90	30.32	6	29.82	29
55–60 N	10–15 W	29.84	29.62	29.48	30.22	1	29.05	23
50–55 N	25–30 W	30.01	30.01	29.90	30.12	18	29.70	27
50–55 N	0– 5 W	29.83	29.74	29.58	30.00	1,20	28.90	28
45–50 N	65–70 W	30.00	30.05	29.98	30.30	5	29.70	25
45–50 N	40–45 W	30.12	30.16	30.15	30.51	6	29.80	1
45–50 N	10–15 W	30.00	29.97	29.92	30.21	1	29.50	27
40–45 N	50–55 W	30.10	30.18	30.20	30.39	22	29.78	1
40–45 N	25–30 W	30.18	30.23	30.24	30.41	17	30.09	28
35–40 N	75–80 W	30.03	30.05	30.01	30.26	27	29.70	24
35–40 N	35–40 W	30.19	30.28	30.32	30.42	26	30.02	2
35–40 N	10–15 W	30.11	30.10	30.17	30.30	24	29.96	22
30–35 N	50–55 W	30.12	30.25	30.23	30.36	12	30.01	1
30–35 N	25–30 W	30.22	30.25	30.29	30.40	16,26	30.10	18,21
25–30 N	90–95 W	30.04	29.99	29.97	30.18	8	29.88	23
25–30 N	60–65 W	30.10	30.17	30.14	30.29	15	30.02	5
25–30 N	15–20 W	30.14	30.13	30.13	30.28	9	29.99	21
15–20 N	35–40 W	30.01	30.06	30.05	30.21	15	29.97	5,24
10–15 N	80–85 W	29.90	29.90	29.92	29.99	26	29.86	3,14

* Mean of last 11 days of the month.

The mean values presented in the above table are based on the interpolated daily pressure for each square on the MS. daily synoptic chart of the North Atlantic Ocean compiled by the Marine Section of the Weather Bureau.

GALES.

Gales occurred on two days in the latter part of the month over a limited area in the northeast section of the ocean; they were not reported on more than one day in any other 5-degree square, and the month was entirely free from tropical hurricanes.

From August 1 to 4 an area of slight atmospheric depression was in the vicinity of the Gulf of St. Lawrence, where light to moderate winds and fog prevailed. During the same period there was also a LOW of much greater intensity over the English Channel and North Sea, that remained nearly stationary. It was impossible to determine the conditions of wind and weather, due to the lack of vessel reports from that locality.

From the 5th to the 8th the atmospheric condition was sluggish, with weak gradients and light winds. On the 9th a LOW was central over the English Channel, and at the same time the Azores HIGH with a crest of 30.33 inches, was unusually well developed, while moderate northwest gales prevailed over the central portion of the steamer lanes. The LOW remained nearly stationary until the 15th, and the movement of the HIGH was likewise slight and irregular. While the intensity of these areas did not vary materially from day to day, the wind velocity decreased, as no gales were reported between the 10th and the 15th.

On the 17th a moderate LOW (1 on Chart IX) was central near Hatteras, where the barometer reading was 29.82 inches. This depression moved northeastward along the coast, and on the 18th the center was near Cape Cod. It then increased its rate of translation, curved toward the east, and was off the coast of Newfoundland on the 19th. Light to moderate winds accompanied the LOW during its movement from the 17th to the 19th, and fog was reported on the latter date off the south coast of Nova Scotia. On the 21st there were slight depressions in the Gulf of St. Lawrence and near the west coast of Ireland, respectively, and one vessel near latitude 51°, longitude 37°, encountered a moderate northeasterly gale. The European LOW remained nearly stationary until the 27th, increasing in intensity, and on the 23d and 24th westerly gales of from 40 to 50 miles an hour prevailed in the southern part of the Irish Channel. On the 27th the center of this disturbance (LOW II on Chart IX) was near Valentia, Ireland, where the barometer reading was 29.03 inches; the highest wind velocities of the month were reported on this date, occurring between the 45th and 50th parallels and the 12th meridian and the French coast, where vessels encountered westerly and southwesterly gales of from 50 to 65 miles an hour. LOW II moved in a northeastward direction and on the 28th surrounded the east coast of England; the barometer reading at Shields of 28.68 inches was the lowest recorded during the month, and northwesterly gales of from 40 to 50 miles an hour prevailed in the southwest quadrant. The LOW then curved sharply toward the north, and on the 29th surrounded the Shetland Islands; it had decreased slightly in intensity since the previous day and was accompanied by light to moderate winds. It then recurved toward the northeast, continuing to decrease in intensity, and on the 30th the center had reached a point near Kristiansund, Norway. Light to moderate winds apparently still prevailed, although it was impossible to determine the conditions accurately on account of lack of sufficient observations.

AIR TEMPERATURES.

The mean monthly temperature of the air as compared with the normal varied considerably over different divisions of the North Atlantic. Positive departures of from 2 to 4 degrees occurred over the northern steamer lanes between the 35th parallel and the American coast,

while over the eastern division the air temperatures were nearly normal, as they also were in the Gulf of Mexico. Small negative departures were the rule over limited areas in midocean, and between the Azores and the Madeiras, while in the region of the northeast trades it was considerably warmer than usual, the departures ranging from +3° to +5°.

The change in temperature from day to day was not especially marked, and the greatest range occurred in the square that includes the east coast of Labrador, where the thermometer reading was 49° on the 3d and 59° on the 18th and again on the 25th.

The following table gives the temperature departures at a number of Canadian and United States Weather Bureau Stations on the Atlantic and Gulf coasts:

	°F.		°F.
St. Johns, New Foundland	+5.4	Norfolk, Va	+1.1
Sydney, Cape Breton Island	+2.7	Hatteras, N. C	+0.6
Halifax, Nova Scotia	+3.4	Charleston, S. C	−0.1
Eastport, Me	+0.5	Key West, Fla	−0.2
Portland, Me	+0.7	Tampa, Fla	+1.4
Boston, Mass	+3.9	Mobile, Ala	+1.3
Nantucket, Mass	+1.2	New Orleans, La	+1.6
Block Island, R. I	+1.9	Galveston, Tex	+0.9
New York, N. Y	+2.4	Corpus Christi, Tex	+0.7

WATER-SURFACE TEMPERATURES.

The mean temperature of the water at the surface varied but little from that of the air, as shown by the isotherms on Chart IX. The temperatures of the two elements as compared with the normal were, as a rule, also similar, although off the Canadian coast the positive departures of the water temperatures were somewhat larger than those of the air, while in the waters adjacent to the coast of New England the conditions were reversed.

FOG.

Off the Banks of Newfoundland the normal percentage of fog in August ranges from 40 to 45, while for the month under discussion it was observed in that region on only 2 days, a percentage of 6. In the area between the 40th and 45th parallels, and the 60th meridian and the North American coast, fog was reported on 6 days, a percentage of 16, which is only slightly below the normal. Fog occurred on from 1 to 3 days over the western part of the steamer lanes, while over the central and eastern divisions it was comparatively rare.

Winds of 50 mis./hr. (22.4 m./sec.) or over, during August, 1918.

Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.
Columbus, Ohio	8	50	sw.	Pierre, S. Dak	28	68	n.
Do	12	72	s.	Point Reyes Light, Cal	3	54	nw.
Hatteras, N. C	24	58	sw.	Do	4	59	nw.
Do	25	64	sw.	Richmond, Va	12	52	nw.
Lexington, Ky	6	72	s.	St. Joseph, Mo	30	60	nw.
Mount Tamalpais, Cal	14	56	sw.	St. Louis, Mo	12	50	s.
New York, N. Y	14	54	nw.	Springfield, Mo	30	58	nw.
Pensacola, Fla	10	53	ne.	Toledo, Ohio	8	52	sw.
Pierre, S. Dak	27	62	nw.				

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by section, August, 1918.

Section.	Temperature.								Precipitation.					
			Monthly extremes.								Greatest monthly.		Least monthly.	
	Section average.	Departure from the normal.	Station.	Highest.	Date.	Station.	Lowest.	Date.	Section average.	Departure from the normal.	Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	80.5	+1.0	3 stations	105	16	St. Bernard	50	22†	3.56	−1.22	Spring Hill	18.26	Cordova	0.00
Arizona	75.7	−1.9	Mohawk	122	2	Fort Valley	34	18	2.31	−0.10	Crown King	9.40	Holbrook	0.19
Arkansas	82.6	+3.2	Searcy	115	4	2 stations	52	14†	3.90	+0.37	Ozark	12.17	Fort Smith	0.99
California	71.4	−1.4	Greenland Ranch	125	3	Portola	26	11†	0.14	+0.06	Needles	2.85	80 stations	0.00
Colorado	64.6	+0.2	Lamar	106	3†	2 stations	25	22†	1.65	−0.22	Akron	7.36	Crawford	0.00
Florida	81.5	+0.2	2 stations	104	15	Mount Pleasant	58	23	5.73	−1.08	Pensacola	14.79	Malabar	1.10
Georgia	80.2	+0.9	Bainbridge	106	15†	Clayton	50	22	4.41	−0.99	St. George	13.50	Washington	1.31
Hawaii (July)	74.4	+0.5	Mahukona	95	12†	Vocano Observatory	51	10	9.05	+3.78	Hakalau (Mauka)	41.71	6 stations	0.00
Idaho	62.3	−3.1	2 stations	103	1†	2 stations	21	11†	0.96	+0.31	Priest River Experiment Station.	4.22	Richfield	T.
Illinois	78.8	+4.8	Hillsboro	112	4	Lincoln	45	1	3.82	+0.47	McLeansboro	7.89	Antioch	0.95
Indiana	78.0	+4.8	2 stations	107	5†	Laporte	36	1	3.25	−0.07	Veedersburg	5.65	Auburn	0.93
Iowa	76.0	+4.2	3 stations	113	4	Sibley	38	30	3.61	−0.07	Centerville	8.38	Thurman	0.47
Kansas	82.3	+4.8	Minneapolis	115	3	2 stations	41	31	2.31	−0.91	Hanover	5.37	Richfield	0.19
Kentucky	80.2	+4.5	2 stations	111	11	3 stations	50	1	3.18	−0.38	Calhoun	7.18	Blandville	1.24
Louisiana	81.9	+0.2	Angola	109	16	Franklinton	59	1†	6.68	+1.02	Avoca Island	17.03	Shreveport	2.23
Maryland-Delaware	76.1	+2.6	2 stations	109	6†	Oakland	40	21	2.95	−1.55	Keedysville	5.50	Delaware City, Del.	0.51
Michigan	69.3	+2.5	2 stations	107	6†	Mancelona	28	3	2.45	−0.24	Munising	5.67	Ganges	0.53
Minnesota	68.5	+2.0	Argyle	101	3	Grand Rapids	32	11	4.05	+0.70	Mankato	9.28	Alexandria	1.20
Mississippi	81.4	+1.0	2 stations	107	15†	Austin	55	1	3.88	−0.54	Pascagoula	11.25	University	0.60
Missouri	81.8	+5.8	4 stations	111	4†	4 stations	45	1†	3.34	−0.27	Columbia	7.83	Clinton	0.68
Montana	63.0	−1.1	Wibaux	110	14	Bowen	15	28	2.01	+0.58	Jordan	6.30	Augusta	0.25
Nebraska	75.3	+2.5	Fremont	115	4	Gordon	32	31	2.34	−0.47	Hardy	6.55	Fremont	0.38
Nevada	67.4	−3.2	2 stations	112	3†	2 stations	28	20†	0.23	−0.18	Mahoney	1.40	6 stations	0.00
New England	68.0	+1.2	2 stations	102	7†	2 stations	32	28†	2.94	−0.91	Northfield, Vt	6.71	Van Buren, Me	0.71
New Jersey	74.4	+2.6	2 stations	108	7	Charlotteburg	40	20	1.85	−3.06	Moorestown	4.25	Clayton	0.34
New Mexico	69.9	−0.2	Pearl (near)	106	2	5 stations	34	14†	2.31	−0.36	Cloudcroft	7.47	Crown Point	0.00
New York	69.8	+2.7	Rhinebeck	106	7	Lake Placid Club	29	18	2.97	−0.60	Bolivar	6.64	Ogdensburg	0.89
North Carolina	77.0	+1.7	4 stations	104	6†	Banners Elk	39	21	4.12	−1.89	Edenton	12.05	Pinehurst	0.59
North Dakota	66.8	+1.4	Napoleon	102	3†	2 stations	34	4†	3.41	+1.13	Jamestown	9.30	Hettinger	0.87
Ohio	76.6	+5.0	Amesville	110	6	Geneva	41	3	3.64	+0.07	2 stations	7.32	Montpelier	0.65
Oklahoma	85.3	+4.6	Sallisaw	113	3	2 stations	45	31	2.02	−1.01	Vinita	8.97	Chattanooga	0.13
Oregon	64.1	−1.7	6 stations	104	3†	Lapine	20	12	0.79	+0.28	Joseph	3.52	Yonna	0.00
Pennsylvania	73.6	+3.9	Claysville	108	6	West Bingham	32	1	4.12	−2.43	Clearfield	8.08	George School	1.05
Porto Rico	79.8	+0.6	Canovanas	100	7	Rio Piedras	57	5	4.04	−3.66	Anasco	15.50	Potala	0.50
South Carolina	80.2	+1.3	Allendale	106	15	2 stations	52	21†	4.45	−1.66	Liberty	8.11	Trenton	1.76
South Dakota	71.2	+1.6	Hopewell	106	3	Pollock	35	31	2.71	+0.07	Harvey's Ranch	5.80	Dowling	0.43
Tennessee	79.5	+3.2	Clarksville	108	11	Erasmus	45	22	2.70	−1.25	Union City	5.90	Dickson	0.52
Texas	84.6	+2.1	2 stations	112	18†	Dalhart	47	31	1.64	−0.73	Woodville	7.24	4 stations	0.00
Utah	67.0	−2.0	St. George	109	3†	Black's Fork	22	18	0.55	−0.52	Lowder Ranger station.	3.60	11 stations	0.00
Virginia	75.8	+2.0	West Point	108	6	Burkes Garden	38	21	4.62	+0.04	Fredericksburg	9.41	Warsaw	1.65
Washington	64.1	−0.8	4 stations	101	1†	4 stations	30	28	1.51	+0.87	Cedar Lake	9.03	Wheeler	0.13
West Virginia	76.0	+4.0	Wheeling	110	6	Parsons	41	20	3.96	−0.01	Camden-on-Gauley	9.15	Dam 26, Ohio River	0.63
Wisconsin	69.5	+3.0	Racine	104	6	3 stations	35	2†	3.49	−0.32	River Falls	9.26	2 stations	0.83
Wyoming	62.9	−0.9	6 stations	100	1†	South Pass City	17	22	0.91	−0.37	Colony	3.72	2 stations	0.00

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS

(*See* the REVIEW, January, 1918, p. 48.)

TABLE I.—*Climatological data for Weather Bureau Stations, August, 1918.*

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.										Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation.			Wind.				Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with .01, or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*		°*F*	°*F.*		°*F*	°*F.*		°*F.*	°*F.*	%	*In.*	*In.*		*Miles*							*0–10*	*In.*	*In.*
New England.							**67.8**	**+0.8**											**75**	**3.09**	**−0.8**									**4.9**		
Eastport	76	67	85	29.95	30.03	+0.07	58.8	−0.9	77	20	66	46	18	51	27		54	52	83	1.57	−1.7	12	5,658	s.	23	nw.	27	10	11	10	5.2		
Greenville	1,070	6	....	28.90	30.04	.....	62.6	.....	88	14	74	37	4	52	35		....	....	....	1.42	.....	12	....	....	....	....	....	17	7	7	....	....	....
Portland, Me	103	82	117	29.94	30.06	+ .08	65.4	−0.8	93	24	73	48	18	58	28		60	57	80	4.64	+1.1	13	5,273	s.	36	s.	14	11	12	8	4.7		
Concord	288	70	79	29.74	30.05	+ .07	68.0	+1.4	95	14	80	40	18	56	38		....	....	....	3.97	+0.2	10	2,367	n.	14	w.	14	21	5	5	3.3		
Burlington	404	11	48	29.61	30.04	+ .07	66.4	+0.3	91	7	76	40	18	56	32		....	....	....	4.01	0.0	11	6,526	s.	36	s.	5	12	10	9	4.9		
Northfield	876	12	60	.....	30.06	+ .08	63.0	+0.1	95	7	77	34	18	51	39		....	....	35	6.71	+2.8	10	4,914	s.	32	nw.	26	9	13	9	5.7		
Boston	125	115	188	29.90	30.04	+ .05	70.4	+1.5	96	14	78	53	18	63	26		63	60	74	1.56	−2.5	8	5,997	e.	38	nw.	14	10	10	11	5.3		
Nantucket	12	14	90	30.04	30.05	+ .06	67.6	−0.4	83	6	74	52	28	61	22		64	62	86	1.62	−1.4	7	10,104	sw.	37	ne.	27	14	6	11	5.3		
Block Island	26	11	46	30.02	30.05	+ .06	69.2	+0.5	90	6	75	58	19	64	22		66	64	88	1.48	−2.0	5	10,099	sw.	34	w.	8	11	8	12	5.5		
Providence	160	215	251	29.87	30.04	+ .05	71.8	+0.8	96	6	81	48	19	63	25		64	61	74	2.41	−1.6	5	6,832	sw.	44	nw.	14	11	10	10	5.0		
Hartford	159	122	140	29.87	30.03	+ .04	72.4	+3.5	100	7	82	51	19	63	29		66	64	79	3.51	−1.0	7	4,700	s.	27	s.	4	15	5	11	4.8		
New Haven	106	117	155	29.94	30.04	+ .05	72.7	+2.6	95	6	81	54	19	64	23		66	63	76	2.51	−2.5	9	5,835	s.	35	sw.	14	18	5	8	4.2		
Middle Atlantic States.							**75.6**	**+2.8**											**74**	**2.61**	**−1.9**									**4.6**		
Albany	97	102	115	29.92	30.02	+ .01	72.6	+3.1	102	7	84	49	18	62	32		65	60	70	3.42	−0.5	10	5,179	s.	33	s.	31	15	9	7	4.0		
Binghamton	871	10	69	29.12	30.04	+ .05	71.4	+3.9	98	6	84	45	18	59	36		....	....	....	3.64	+0.3	11	2,241	ne.	19	s.	31	18	7	6	3.8		
New York	314	414	454	29.71	30.04	+ .04	74.8	+2.6	102	7	82	60	20	67	24		67	63	71	1.70	−2.8	8	10,096	sw.	54	nw.	14	9	14	8	5.2		
Harrisburg	374	94	104	29.66	30.05	+ .04	75.6	+3.5	104	6	85	54	21	66	29		67	63	72	2.54	−1.7	13	3,475	w.	31	w.	13	12	8	11	5.5		
Philadelphia	117	123	190	29.91	30.04	+ .04	77.6	+3.8	106	7	86	62	20	69	24		68	64	70	3.35	−1.3	9	6,323	sw.	30	nw.	13	9	13	9	5.2		
Reading	325	81	98	29.71	30.05	.....	76.4	.....	105	7	87	55	20	66	28		67	63	70	3.00	−1.5	10	3,878	sw.	34	n.	13	16	8	7	4.4		
Scranton	805	111	119	29.20	30.05	+ .05	73.3	+4.0	102	7	84	50	20	63	32		65	61	71	4.04	−0.2	12	3,486	sw.	27	nw.	14	14	11	6	4.5		
Atlantic City	52	37	48	29.99	30.04	+ .04	74.8	+2.2	104	7	80	57	20	70	24		69	67	79	1.38	−2.9	5	5,232	sw.	25	w.	7	12	14	5	4.1		
Cape May	18	13	49	30.05	30.07	+ .07	75.0	+1.6	100	7	81	54	20	68	26		....	....	....	0.48	−3.8	9	.....	s.	....	....	....	....	....	....	3.4		
Sandy Hook	22	10	57	30.02	30.04	.....	75.0	.....	98	7	82	62	20	68	22		68	65	76	0.66	.....	7	9,350	sw.	45	nw.	14	18	7	6	4.3		
Trenton	190	159	183	29.83	30.03	.....	75.4	.....	105	7	85	55	20	66	26		67	64	75	2.52	−2.8	9	6,859	sw.	37	w.	8	9	13	9	5.2		
Baltimore	123	100	113	29.92	30.05	+ .04	78.3	+3.6	105	6	87	58	20	70	32		69	65	70	3.35	−0.9	8	4,563	s.	25	nw.	9	15	10	6	4.9		
Washington	112	62	85	29.93	30.04	+ .03	77.6	+3.1	106	6	88	53	20	68	31		69	67	76	1.88	−2.5	12	3,639	sw.	38	nw.	7	13	12	6	4.8		
Lynchburg	681	153	188	29.33	30.06	+ .04	77.6	+2.8	105	6	89	51	20	66	31		68	66	74	2.91	−1.3	9	3,964	w.	36	w.	26	12	12	7	5.2		
Norfolk	91	170	205	29.96	30.05	+ .05	79.6	+2.9	105	7	88	62	22	71	25		72	69	78	2.48	−3.5	9	7,571	sw.	38	nw.	10	12	13	6	4.6		
Richmond	144	11	52	29.90	30.05	+ .04	78.3	+0.8	107	6	89	55	20	68	31		70	68	78	2.76	−1.6	9	4,402	s.	52	nw.	12	6	17	8	5.9		
Wytheville	2,293	49	55	27.76	30.07	+ .06	72.4	+1.9	93	6	83	45	21	62	34		66	64	82	2.33	−2.2	9	3,217	w.	24	nw.	7	12	14	5	4.0		
South Atlantic States.							**79.6**	**+1.8**											**78**	**3.91**	**−2.2**									**4.3**		
Asheville	2,255	70	84	27.81	30.10	+ .08	72.8	+2.3	95	6	83	49	21	62	32		65	64	84	5.07	+0.3	12	3,749	nw.	36	e.	11	9	16	6	5.1		
Charlotte	773	153	161	29.24	30.03	+ .04	78.8	+2.2	99	6	89	56	20	68	29		70	68	76	2.18	−3.4	7	2,843	sw.	40	nw.	31	11	13	7	4.7		
Hatteras	11	12	50	30.03	30.04	+ .04	78.4	+0.2	92	13	83	67	19	74	15		74	72	83	3.10	−2.7	7	9,704	sw.	64	sw.	25	17	9	5	3.8		
Manteo	12	4	46	.....	.....	.....	78.3	.....	99	9	86	60	21	70	....		....	....	....	7.80	.....	7	.....	sw.	....	....	....	21	2	8	.....	....	....
Raleigh	376	103	110	29.66	30.04	+ .03	79.2	+2.4	99	14	89	56	20	69	25		71	68	76	2.41	−3.5	7	4,631	sw.	32	sw.	28	14	9	8	4.8		
Wilmington	78	81	91	29.97	30.05	+ .05	79.8	+2.2	98	13	88	60	21	72	24		73	71	82	6.13	−0.4	9	5,532	sw.	38	nw.	24	17	7	7	3.8		
Charleston	48	11	92	30.01	30.06	+. 05	82.2	+1.9	99	14	90	67	21	75	21		74	72	76	2.87	−4.1	7	7,363	sw.	36	nw.	16	16	10	5	4.1		
Columbia, S. C	351	41	57	29.69	30.07	+ .06	80.8	+1.3	100	14	91	61	21	71	29		71	66	69	4.78	−2.0	9	4,047	sw.	28	se.	9	17	9	5	4.2		
Greenville, S. C	1,013	113	122	28.98	30.06	.....	77.5	.....	96	6	87	58	22	68	28		70	68	78	3.07	.....	11	4,871	ne.	45	nw.	10	16	10	5	3.7		
Augusta	180	62	77	29.87	30.06	+ .05	81.3	+2.4	101	15	92	60	22	71	31		72	70	75	4.70	−0.9	10	3,577	s.	31	nw.	31	14	7	10	4.9		
Savannah	65	150	194	30.00	30.07	+ .06	81.2	+1.8	100	15	90	65	21	72	24		73	71	80	4.78	−2.7	12	7,208	sw.	35	e.	19	13	8	10	4.8		
Jacksonville	43	200	245	30.02	30.07	+ .06	81.2	+1.1	96	15	90	66	10	73	26		74	72	80	3.12	−3.1	14	7,753	sw.	49	w.	10	17	11	3	3.8		
Florida Peninsula.							**82.8**	**+0.4**											**75**	**3.80**	**−3.2**									**5.2**		
Key West	22	10	64	30.00	30.02	+0.04	84.4	+0.6	92	19	89	74	21	80	15		76	73	72	1.85	−2.8	11	7,427	e.	24	nw.	15	12	13	6	4.8		
Miami	25	71	79	30.03	30.06	.....	81.5	−0.5	92	15	87	71	17	76	18		76	74	77	1.43	−6.2	15	6,403	e.	29	e.	5	7	18	6	5.5		
Sand Key	23	39	72	29.98	30.01	+ .03	82.0	.....	89	19	85	73	21	79	11		77	74	75	2.48	.....	11	10,592	e.	39	se.	29	13	11	7	4.6		
Tampa	35	79	92	30.03	30.06	+ .06	82.5	+1.1	97	15	92	70	21	73	25		74	71	77	8.11	−0.5	16	3,888	ne.	35	e.	29	0	25	6	6.0		
East Gulf States.							**80.5**	**+1.3**											**76**	**6.21**	**+1.3**									**5.0**		
Atlanta	1,174	190	216	28.88	30.09	+0.08	78.8	+2.7	95	15	88	61	21	70	24		69	66	70	4.20	−0.3	9	5,820	w.	40	nw.	31	14	6	11	4.8		
Macon	370	78	87	29.69	30.08	+ .07	79..	+1.6	98	14	90	58	22	69	33		71	67	71	2.23	−2.0	6	3,669	s.	33	se.	16	16	7	8	4.5		
Thomasville	273	49	58	29.78	30.07	+ .07	80.4	−0.6	99	15	90	62	23	70	29		72	69	77	6.16	+1.1	13	2,683	ne.	26	ne.	16	12	9	10	5.3		
Pensacola	56	149	185	30.00	30.06	+ .08	79.9	−1.1	99	16	86	67	26	74	19		74	73	81	14.79	+7.6	13	7,746	s.	53	ne.	10	10	11	10	5.3		
Anniston	741	9	57	29.32	30.10	+ .11	78.4	+2.0	97	15	90	54	22	67	37		....	....	....	2.71	−1.8	9	2,783	s.	20	nw.	31	16	12	3	3.4		
Birmingham	700	11	48	29.32	30.08	+ .09	81.5	+1.7	100	15	92	63	22	70	30		70	67	71	0.98	−3.5	7	3,912	s.	25	ne.	15	15	12	4	3.9		
Mobile	57	125	161	30.00	30.06	+ .08	81.2	+1.5	101	16	88	69	27	74	27		74	72	81	14.16	+7.4	15	5,824	sw.	38	n.	16	8	13	10	5.2		
Montgomery	223	109	112	29.83	30.07	+ .08	81.6	+1.9	100	16	91	63	22	72	27		72	69	73	4.95	+0.7	10	3,857	sw.	37	w.	27	10	15	6	4.8		
Corinth	469	6	....	....	....	....	....	....	....	....	....	....	....	....	....		....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Jackson	304	5	....	....	....	....	....	....	....	....	....	....	....	....	....		....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Meridian	375	85	93	29.66	30.04	+ .06	80.7	+2.2	99	16	91	64	23	71	29		72	68	72	4.96	+1.4	10	3,090	sw.	19	e.	10	11	10	10	5.0		
Vicksburg	247	65	74	29.78	30.06	+ .08	81.5	+1.9	100	16	91	69	13	72	25		73	71	79	6.96	+3.4	9	3,866	se.	29	e.	18	8	13	10	5.4		
New Orleans	51	76	84	29.99	30.04	+ .06	82.0	+1.0	98	16	89	70	26	75	22		76	74	82	6.19	+0.6	14	3,542	se.	32	ne.	17	2	17	12	6.7		
West Gulf States.							**83.8**	**+2.8**											**78**	**1.82**	**−1.2**									**4.0**		
Shreveport	249	77	93	29.75	30.01	+0.04	83.4	+2.0	102	17	94	68	7	73	27		73	69	73	2.23	0.0	12	4,783	s.	38	se.	7	17	12	2	3.6		
Bentonville	1,303	11	44	28.66	29.99	+ .02	80.8	+4.3	103	3	93	59	31	69	34		....	....	....	4.88	+0.8	10	3,403	s.	22	sw.	15	17	7	7	4.0		
Fort Smith	457	79	94	29.50	29.96	− .01	85.0	+5.6	106	3	97	67	1	73	32		71	65	61	0.99	−2.7	6	5,291	e.	34	n.	16	14	12	5	4.0		
Little Rock	357	139	147	29.64	30.01	+ .03	82.8	+3.6	102	4	92	65	1	73	28		70	66	64	1.42	−2.2	9	5,707	s.	39	nw.	25	11	10	10	5.1		
Brownsville	57	4	26	.....	.....	.....	85.7	.....	100	28	96	68	1	75	26		....	....	....	0.40	.....	4	.....	se.	....	....	....	....	....	....	....	....	....
Corpus Christi	20	69	77	29.97	29.99	+ .06	82.8	+0.7	91	19	88	75	2	78	14		77	75	81	0.15	−2.1	3	9,383	se.	34	se.	7	18	10	3	3.4		
Dallas	512	109	117	29.46	30.00	.....	86.2	.....	104	19	97	71	27	76	26		....	....	....	2.48	.....	3	6,652	se.	33	se.	19	18	12	1	3.1		
Fort Worth	670	106	114	29.23	29.92	− .02	87.0	+4.1	103	19	98	71	27	76	27		71	64	54	0.29	−1.6	2	7,887	se.	36	se.	19	19	8	4	3.4		
Galveston	54	106	114	29.95	30.02	+ .06	82.7	+0.1	90	18	87	71	2	79	15		76	73	75	3.04	−2.0	8	7,166	s.	32	n.	6	8	16	7	5.5		
Houston	138	111	121	29.87	30.01	.....	83.7	+0.8	98	4	93	69	31	75	24		....	....	....	1.68	.....	9	4,887	se.	26	se.	7	10	14	7	4.8		
Palestine	510	64	72	29.47	29.99	+ .02	83.8	+3.3	102	18	94	66	31	73	26		73	70	73	2.41	+0.2	9	4,987	se.	35	sw.	8	16	5	10	4.3		
Port Arthur	34	58	66	29.97	30.01	.....	81.2	.....	94	17	88	69	21	75	21		75	73	80	5.42	.....	12	5,354	s.	46	nw.	6	12	14	5	4.4		
San Antonio	701	119	132	29.25	29.96	+ .03	85.1	+3.1	99	22	96	69	24	74	27		72	67	65	2.61	−0.1	3	5,844	s.	35	n.	24	23	8	0	2.4		
Taylor	582	55	63	29.40	30.01	+ .06	85.0	+3.3	100	18	96	68	26	74	28		....	....	....	0.17	−2.3	3	5,671	se.	38	ne.	31	11	15	5	4.6		

TABLE I.—*Climatological data for Weather Bureau Stations, August, 1918*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.											Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.						Total.	Departure from normal.	Days with .01 or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*		°*F*	°*F.*		°*F*	°*F.*		°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Ohio Valley and Tennessee.							**79.0**	**+4.6**												**69**	**3.45**	**0.0**									**4.8**		
Chattanooga	762	189	213	29.27	30.07	+0.07	80.2	+3.7	97	14	91	60	22	70	32	69	66	68	1.28	−2.5	8	4,491	sw.	46	nw.	10	10	19	2	4.6	.....	.....
Knoxville	996	102	111	29.02	30.05	+ .04	79.2	+4.5	97	6	90	62	22	69	27	69	66	72	2.41	−1.6	8	3,370	sw.	30	sw.	4	12	14	5	4.7	.....	.....
Memphis	399	76	97	29.63	30.05	+ .07	82.6	+3.4	100	17	92	65	1	74	25	72	68	68	2.56	−0.6	8	5,494	sw.	38	nw.	31	19	8	4	3.2	.....	.....
Nashville	546	168	191	29.48	30.05	+ .05	81.2	+3.4	99	10	91	58	1	71	31	70	65	65	3.05	−0.4	7	5,151	w.	40	s.	18	22	5	4	3.3	.....	.....
Lexington	989	193	230	29.01	30.05	+ .04	79.4	+4.8	100	6	89	63	20	70	29	.....	.....	.....	2.68	−0.9	9	7,830	sw.	72	s.	6	14	13	4	4.1	.....	.....
Louisville	525	219	255	29.47	30.04	+ .04	81.4	+4.9	105	5	91	61	1	72	30	70	65	64	3.25	−0.3	9	6,906	s.	48	se.	6	18	10	3	2.9	.....	.....
Evansville	431	139	175	29.56	30.02	+ .03	82.4	+5.4	104	5	92	62	1	73	27	72	67	66	3.03	−0.2	9	6,309	sw.	37	n.	14	8	19	4	4.7	.....	.....
Indianapolis	822	194	230	29.15	30.01	+ .01	78.4	+4.8	103	5	87	61	1	70	25	69	64	67	2.24	−1.1	14	6,714	sw.	44	nw.	28	6	15	10	6.0	.....	.....
Terre Haute	575	96	129	29.38	29.99	.....	79.5	.....	105	5	88	57	1	71	30	70	67	71	2.57	.....	9	5,550	sw.	31	sw.	8	4	21	6	6.4	.....	.....
Cincinnati	628	11	51	29.36	30.02	+ .01	78.6	+7.0	101	6	89	55	1	68	31	69	65	70	4.53	+1.2	9	4,257	sw.	29	nw.	14	13	11	7	4.6	.....	.....
Columbus	824	173	222	29.18	30.03	+ .02	77.6	+4.6	103	5	87	56	1	68	28	68	64	68	4.42	+1.2	11	6,694	s.	68	n.	12	6	14	11	5.8	.....	.....
Dayton	899	181	216	29.06	29.99	.....	78.0	+4.4	103	5	88	56	1	69	28	68	63	67	3.44	+0.4	13	5,869	sw.	36	s.	12	8	17	6	5.2	.....	.....
Pittsburgh	842	353	410	29.15	30.04	+ .03	76.6	+4.1	103	6	86	57	1	67	28	67	63	66	4.84	+1.7	12	6,722	sw.	46	s.	13	7	14	10	5.3	.....	.....
Elkins	1,940	41	50	28.07	30.06	+ .04	72.2	+3.8	99	6	83	45	21	61	36	65	63	82	5.43	+1.8	11	2,728	w.	30	nw.	26	4	13	14	6.3	.....	.....
Parkersburg	638	77	84	29.41	30.06	+ .05	78.6	+5.3	106	6	90	55	1	67	32	69	66	74	5.14	+1.6	13	3,097	se.	40	sw.	7	12	8	11	5.4	.....	.....
Lower Lake Region.							**72.8**	**+3.1**												**68**	**2.14**	**−0.9**									**4.6**		
Buffalo	767	247	280	29.21	30.02	+0.03	70.6	+1.8	86	7	78	52	19	64	25	64	60	70	3.02	0.0	12	10,223	sw.	39	w.	26	10	14	7	5.3	.....	.....
Canton	448	10	61	29.55	30.01	.....	67.0	−0.8	93	7	78	39	18	56	34	.....	.....	.....	3.18	+0.5	11	6,105	sw.	34	sw.	23	18	9	4	3.3	.....	.....
Oswego	335	76	91	29.65	30.01	+ .02	69.5	+0.7	94	13	78	52	18	62	28	63	58	69	2.56	−0.1	12	5,945	s.	24	ne.	26	14	9	8	4.4	.....	.....
Rochester	523	97	113	29.47	30.04	+ .05	71.4	+3.1	97	13	81	49	1	62	29	63	58	65	1.83	−1.1	11	5,183	sw.	25	w.	26	11	13	7	4.5	.....	.....
Syracuse	597	97	113	29.40	30.04	+ .05	71.0	+2.4	96	7	81	46	18	61	28	.....	.....	.....	1.45	−1.9	9	6,652	s.	34	s.	28	16	13	2	4.1	.....	.....
Erie	714	130	166	29.26	30.01	.00	73.4	+3.5	96	6	81	54	1	66	24	66	62	68	1.68	−1.6	8	8,821	s.	41	s.	8	10	16	5	4.7	.....	.....
Cleveland	762	190	201	29.22	30.02	+ .01	74.5	+4.1	100	6	81	54	1	68	23	66	61	65	2.47	−0.7	9	8,129	sw.	46	w.	8	11	17	3	4.5	.....	.....
Sandusky	629	62	103	29.35	30.02	+ .01	75.6	+4.1	105	6	84	56	1	68	24	.....	.....	.....	1.76	−1.6	10	7,741	sw.	38	nw.	31	8	14	9	5.5	.....	.....
Toledo	628	208	243	29.35	30.02	+ .02	76.2	+5.3	103	6	85	53	3	67	28	67	63	69	2.11	−0.6	11	9,109	sw.	52	sw.	8	12	13	6	4.6	.....	.....
Fort Wayne	856	113	124	29.12	30.03	.....	76.3	+5.2	102	5	87	52	1	66	32	66	62	67	1.06	.....	7	6,068	sw.	25	sw.	8	7	17	7	5.2	.....	.....
Detroit	730	218	245	29.25	30.02	+ .01	74.8	+4.9	104	6	84	50	3	65	28	65	61	68	1.29	−1.5	9	7,366	sw.	32	sw.	23	9	18	4	4.8	.....	.....
Upper Lake Region.							**68.7**	**+2.4**												**73**	**1.98**	**−1.0**									**4.8**		
Alpena	609	13	92	29.36	30.03	+0.03	65.4	+1.6	96	13	74	46	3	56	35	60	57	76	3.17	−0.2	11	6,899	se.	37	nw.	28	10	14	7	5.3	.....	.....
Escanaba	612	54	60	29.34	29.99	.00	65.4	+0.9	84	11	73	48	3	58	25	60	57	79	2.78	−0.8	11	6,253	s.	34	s.	22	13	9	9	4.4	.....	.....
Grand Haven	632	54	92	29.32	29.99	.00	70.2	+2.4	95	12	80	51	1	61	30	63	59	71	0.83	−1.8	7	7,331	s.	28	s.	22	10	16	5	4.7	.....	.....
Grand Rapids	707	70	87	29.25	30.00	.00	74.1	+4.1	102	6	85	51	3	63	31	64	58	60	0.84	−1.8	7	3,998	w.	18	w.	28	11	15	5	4.7	.....	.....
Houghton	684	62	99	29.26	29.98	+ .01	64.3	+1.0	88	22	73	44	2	55	31	.....	.....	.....	1.88	−1.0	12	7,083	e.	36	nw.	12	12	11	8	4.7	.....	.....
Lansing	878	11	62	29.08	30.00	.....	72.2	+3.6	102	6	85	45	3	59	35	64	60	71	1.44	−1.2	8	3,312	sw.	22	sw.	11	9	15	7	5.1	.....	.....
Ludington	637	60	66	29.31	30.00	.....	67.2	.....	88	12	76	50	27	58	32	61	57	72	1.48	.....	9	6,622	s.	35	s.	28	14	14	3	3.9	.....	.....
Marquette	734	77	111	29.22	30.02	+ .04	63.6	+0.1	90	25	72	44	2	55	28	58	55	78	3.20	+0.3	14	5,952	e.	.....	.....	.....	9	12	10	5.3	.....	.....
Port Huron	638	70	120	29.33	30.02	+ .02	72.2	+4.9	104	6	82	49	1	62	33	64	61	72	1.80	−0.8	9	6,903	ne.	33	nw.	14	12	17	2	3.8	.....	.....
Saginaw	641	48	82	29.32	30.01	.....	72.3	.....	103	6	84	48	3	61	35	63	59	68	1.85	−1.0	7	5,687	s.	28	nw.	13	7	19	5	4.9	.....	.....
Sault Sainte Marie	614	11	61	29.32	30.00	+ .01	62.0	+1.4	85	25	71	47	19	53	33	59	57	85	3.19	0.0	15	5,378	se.	36	nw.	28	12	9	10	5.6	.....	.....
Chicago	823	140	310	29.13	30.00	.00	75.7	+4.5	102	5	82	59	31	69	30	67	63	67	1.27	−1.6	10	7,258	sw.	32	nw.	4	11	14	6	4.7	.....	.....
Green Bay	617	109	144	29.33	29.98	− .01	70.3	+3.3	98	6	80	52	31	61	34	62	58	70	2.05	−1.0	9	7,113	sw.	36	sw.	7	11	13	7	5.4	.....	.....
Milwaukee	681	119	133	29.26	30.00	.00	72.6	+3.9	101	6	81	55	31	64	35	65	61	73	1.17	−1.6	9	7,377	sw.	37	e.	18	11	14	6	4.7	.....	.....
Duluth	1,133	11	47	28.76	29.96	− .01	64.6	−0.3	90	4	74	46	31	56	33	58	54	74	2.32	−1.2	12	8,492	ne.	33	sw.	22	12	14	5	4.3	.....	.....
North Dakota.							**67.4**	**+0.4**												**68**	**3.36**	**+1.1**									**4.0**		
Moorhead	940	8	57	28.95	29.95	−0.01	69.4	+3.5	98	3	82	44	29	57	36	61	58	74	4.90	+1.8	13	5,401	se.	36	n.	9	19	8	4	3.1	.....	.....
Bismarck	1,674	8	57	28.20	29.95	+ .01	68.8	+0.7	97	3	82	43	31	56	39	59	53	64	2.62	+0.6	8	7,446	nw.	47	w.	21	17	10	4	3.8	.....	.....
Devils Lake	1,482	11	44	28.36	29.91	− .03	65.2	+0.1	94	3	77	41	30	54	34	58	53	71	2.25	−0.5	13	6,890	se.	38	se.	19	12	14	5	4.7	.....	.....
Ellendale	1,457	10	56	28.40	29.94	.....	67.6	.....	95	3	80	43	26	55	37	60	56	72	3.47	.....	12	9,085	nw.	40	s.	3	13	10	8	4.8	.....	.....
Grand Forks	835	12	89	.....	.....	.....	67.3	.....	98	3	80	44	11	55	37	61	.....	.....	3.94	.....	9	.....	w.	40	sw.	22	21	8	2	.....	.....	.....
Williston	1,872	41	48	27.95	29.89	− .04	66.3	−1.6	93	2	78	43	7	55	41	57	51	63	3.66	+2.4	11	5,848	w.	39	ne.	21	10	15	6	4.6	.....	.....
Upper Mississippi Valley.							**77.0**	**+4.1**												**69**	**4.01**	**+0.8**									**4.9**		
Minneapolis	918	10	208	28.97	29.94	.....	70.9	.....	92	12	80	52	29	62	27	.....	.....	.....	3.73	0.0	13	7,412	se.	35	e.	22	6	14	11	6.1	.....	.....
St. Paul	837	201	238	29.06	29.95	−0.02	70.4	+0.9	89	25	79	50	31	62	27	.....	.....	.....	5.19	+1.7	13	7,634	se.	46	sw.	21	10	15	6	4.8	.....	.....
La Crosse	714	11	48	29.20	29.96	− .02	71.5	+1.5	96	6	82	47	31	61	32	.....	.....	.....	2.84	−0.6	9	2,535	se.	16	nw.	7	7	15	9	5.8	.....	.....
Madison	974	70	78	28.97	29.99	.00	72.6	+3.0	97	5	82	54	31	63	31	64	60	70	2.03	−1.2	6	5,590	sw.	35	nw.	13	9	13	9	5.5	.....	.....
Wausau	1,247	4	.....	28.67	29.98	.....	67.4	.....	91	6	78	48	31	57	28	.....	.....	.....	4.59	.....	9	.....	e.	.....	.....	.....	18	9	4	3.8	.....	.....
Charles City	1,015	10	49	28.91	29.96	− .01	72.2	+1.5	98	5	83	46	31	62	30	65	62	76	5.48	+2.1	8	3,945	se.	22	ne.	4	8	20	3	4.5	.....	.....
Davenport	606	71	79	29.32	29.97	− .01	76.8	+3.8	101	5	87	54	31	67	30	68	64	69	3.38	−0.3	10	4,920	e.	24	e.	4	13	10	8	4.5	.....	.....
Des Moines	861	84	97	29.04	29.92	− .05	78.7	+5.7	110	4	90	50	31	68	36	67	62	61	2.54	−1.1	9	5,213	sw.	38	sw.	12	13	11	7	4.7	.....	.....
Dubuque	698	81	96	29.25	29.98	.00	74.6	+2.6	98	12	84	53	31	65	29	66	63	73	6.09	+3.0	13	3,896	s.	29	nw.	13	11	9	11	5.4	.....	.....
Keokuk	614	64	78	29.31	29.97	− .01	80.8	+6.2	108	4	92	55	31	70	32	71	64	64	3.24	0.0	11	4,822	s.	36	sw.	13	14	16	1	3.6	.....	.....
Cairo	356	87	93	29.62	29.99	.00	81.6	+4.6	102	3	91	64	1	72	29	71	67	70	1.62	−1.3	7	4,963	s.	35	nw.	9	11	12	8	5.3	.....	.....
Peoria	609	11	45	29.33	29.99	.00	77.5	+5.0	104	5	88	55	31	67	34	69	67	78	5.88	+3.0	11	3,624	s.	25	w.	30	12	14	5	4.3	.....	.....
Springfield, Ill	644	10	91	29.31	29.97	− .02	80.1	+6.1	106	4	90	57	1	70	33	70	66	71	3.46	+0.7	11	4,895	s.	22	w.	30	8	15	8	6.0	.....	.....
Hannibal	534	74	109	29.41	29.97	− .01	81.6	+6.6	108	4	92	55	31	71	33	.....	.....	.....	5.40	+2.0	11	6,328	sw.	48	w.	30	10	14	7	4.6	.....	.....
St. Louis	567	265	303	29.38	29.98	− .01	82.6	+5.4	105	4	91	62	31	74	25	70	65	62	5.26	+2.6	12	8,820	s.	50	s.	12	13	14	4	4.2	.....	.....
Missouri Valley.							**78.6**	**+4.8**												**62**	**2.65**	**−0.7**									**4.0**		
Columbia, Mo	781	11	84	29.16	29.96	−0.01	81.7	+7.0	108	4	93	56	31	70	36	.....	.....	.....	7.83	+4.8	11	4,937	s.	36	sw.	9	12	15	4	4.5	.....	.....
Kansas City	963	161	181	28.93	29.92	− .05	83.8	+8.0	108	3	95	55	31	73	36	68	60	54	2.45	−2.3	10	7,529	s.	41	se.	16	19	8	4	3.5	.....	.....
St. Joseph	967	11	49	28.92	29.91	.....	82.6	.....	109	3	94	54	31	71	40	68	61	58	3.28	.....	11	5,285	s.	60	nw.	30	23	3	5	2.5	.....	.....
Springfield, Mo	1,324	98	104	28.62	29.99	+ .02	80.0	+5.2	101	4	90	57	31	70	29	67	62	63	3.12	−1.2	9	6,741	s.	58	nw.	30	15	11	5	3.8	.....	.....
Iola	984	11	50	28.93	29.94	− .02	83.8	+7.5	107	3	97	52	31	70	39	.....	.....	.....	1.50	−2.0	9	4,763	s.	24	sw.	14	14	15	2	4.1	.....	.....
Topeka	983	85	101	.....	.....	.....	83.4	+7.4	109	3	96	52	31	71	38	.....	.....	.....	3.24	−1.0	8	7,086	s.	32	sw.	14	16	12	3	3.3	.....	.....
Drexel	1,299	10	54	28.55	29.90	.....	79.0	.....	110	4	92	46	31	66	39	66	61	61	0.70	.....	10	7,469	se.	36	sw.	12	13	12	6	4.6	.....	.....
Lincoln	1,189	11	84	28.66	29.89	− .06	80.9	+6.6	109	4	94	50	31	68	41	67	60	57	0.77	−2.9	9	6,886	s.	33	ne.	28	11	15	5	4.7	.....	.....
Omaha	1,105	115	122	28.76	29.91	− .05	80.8	+6.4	110	4	91	54	31	70	32	66	60	56	1.14	−2.5	8	5,168	se.	31	n.	28	14	13	4	4.2	.....	.....
Valentine	2,598	47	54	27.28	29.94	.00	72.6	+1.3	98	3	86	43	31	60	45	62	56	64	1.71	−1.1	8	6,046	s.	35	ne.	28	19	9	3	4.1	.....	.....
Sioux City	1,135	94	164	28.74	29.91	− .04	75.8	+3.2	97	3	86	49	29	66	34	68	65	73	2.64	−0.4	9	7,184	se.	51	s.	15	9	17	5	4.5	.....	.....
Huron	1,306	59	74	28.57	29.94	− .01	71.6	+2.5	92	27	83	46	29	60	35	64	60	72	2.73	+0.1	11	6,619	se.	48	nw.	28	13	15	3	4.3	.....	.....
Pierre	1,572	70	75	28.28	29.91	− .03	74.2	+1.1	101	3	87	48	31	62	39	63	56	61	2.30	+0.3	10	6,928	e.	68	n.	28	19	8	4	3.5	.....	.....
Yankton	1,233	49	57	28.62	29.91	− .04	74.3	+1.5	98	3	85	47	31	64	36	.....	.....	.....	2.42	−0.7	14	4,580	se.	35	n.	28	8	17	6	5.4	.....	.....

TABLE I.—*Climatological data for Weather Bureau Stations, August, 1918*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.										Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation.			Wind.				Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with .01, or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F*		*°F*	*°F.*		*°F*	*°F.*		*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles.*								*0–10*	*In.*	*In.*
Northern Slope.							**65.8**	**−0.9**											**58**	**1.42**	**+0.1**									**4.2**		
Billings	3,140	5																														
Havre	2,505	11	44	27.32	29.91	0.00	66.6	−0.3	97	1	80	39	28	54	41		56	50	65	2.61	+1.4	15	5,101	sw.	30	sw.	12	11	13	7	5.1		
Helena	4,110	87	114	25.82	29.94	.00	63.4	−2.7	90	1	76	39	28	51	35		51	42	52	0.96	+0.3	9	6,337	sw.	48	sw.	17	14	11	6	4.5		
Kalispell	2,962	11	34	26.94	29.95	+ .02	60.1	−2.8	90	1	72	36	28	48	37		51	44	64	0.96	+0.1	14	4,011	nw.	27	sw.	15	9	11	11	5.5		
Miles City	2,371	26	48	27.44	29.95	+ .02	71.2	−0.3	96	3	84	45	30	59	38		59	53	61	1.08	0.0	11	4,578	n.	41	nw.	3	18	13	0	3.1		
Rapid City	3,259	50	58	26.62	29.96	+ .03	69.9	+1.1	96	2	83	47	31	57	36		57	50	54	2.64	+0.5	11	5,970	w.	34	n.	9	16	14	1	3.5		
Cheyenne	6,088	84	101	24.10	29.94	+ .02	65.0	−0.8	92	2	78	42	31	52	41		54	47	61	1.68	+0.2	12	7,117	s.	44	nw.	5	7	14	10	5.3		
Lander	5,372	60	68	24.69	29.92	.00	64.9	−0.8	93	1	82	39	22	48	46		49	36	45	0.27	−0.3	4	4,018	sw.	40	sw.	21	18	11	2	3.5		
Sheridan	3,790	10	47	26.12	29.96		65.8		93	2	82	40	31	50	47		55	48	61	0.93		8	3,803	nw.	38	sw.	21	15	12	4	4.2		
Yellowstone Park	6,200	11	48		29.98	+ .05	57.0	−3.9	82	1	71	34	28	43	40				53	0.86	−0.2	10	4,797	s.	39	s.	11	14	15	2			
North Platte	2,821	11	51	27.09	29.96	+ .02	74.0	+1.8	102	3	88	47	31	60	42		63	58	67	1.73	−0.7	8	4,195	e.	25	n.	23	19	10	2	2.9		
Middle Slope.							**79.5**	**+4.2**											**51**	**2.15**	**−0.3**									**3.9**		
Denver	5,292	106	113	24.80	29.94	+0.02	70.6	+0.2	93	1	83	52	24	58	34		56	48	53	1.31	0.0	9	4,855	s.	31	nw.	5	6	22	3	5.0		
Pueblo	4,685	80	86	25.34	29.92	+ .01	73.9	+1.8	99	1	88	48	31	60	42		57	46	49	0.57	−1.0	9	4,087	nw.	39	w.	2	8	17	6	5.1		
Concordia	1,392	50	58	28.48	29.90	− .05	82.5	+6.0	110	3	95	50	31	70	40		66	58	53	3.10	+0.3	9	6,024	s.	28	sw.	10	11	17	3	4.2		
Dodge City	2,509	11	51	27.38	29.91	− .02	80.6	+4.1	104	3	94	47	31	68	36		64	57	53	0.84	−1.8	6	7,741	s.	36	ne.	30	21	8	2	2.9		
Wichita	1,358	139	158	28.51	29.90	− .05	83.7	+6.2	105	3	95	52	31	72	32		67	59	51	5.19	+2.1	11	10,146	s.	49	se.	30	17	12	2	3.5		
Altus	1,410	5					86.8		107	19	102	65	31	72	38					0.65		4		s.				24	5	2			
Muskogee	652	4					85.7		106	3	100	62	2	72	43					2.26		5		s.				8	3	20			
Oklahoma	1,214	10	47	28.69	29.93	− .01	85.6	+7.1	105	3	99	61	31	72	33		67	59	49	1.91	−1.3	7	8,743	s.	42	sw.	8	21	6	4	2.8		
Southern Slope.							**81.5**	**+2.4**											**52**	**1.76**	**−0.9**									**2.9**		
Abilene	1,738	10	52	28.16	29.90	−0.02	86.0	+4.8	102	19	98	65	1	74	35		67	56	42	3.00	+1.0	2	7,378	s.	40	sw.	8	23	7	1	2.3		
Amarillo	3,676	10	49	26.31	29.95	+ .03	78.0	+3.4	98	2	91	55	31	65	33		62	55	55	2.36	−0.4	8	7,898	s.	38	s.	7	17	13	1	3.6		
Del Rio	944	64	71	28.96	29.93	+ .03	85.4	+1.4	99	19	96	69	26	75	28					0.28	−2.3	4	7,938	se.	40	sw.	8	25	5	1	2.0		
Roswell	3,566	75	85	26.37	29.90	+ .02	76.6	0.0	100	30	90	59	18	64	39		62	55	59	1.40	−0.1	8	4,788	s.	34	w.	22	12	17	2	3.8		
Southern Plateau.							**75.1**	**−2.2**											**50**	**1.51**	**+0.2**									**3.2**		
El Paso	3,762	110	133	26.19	29.86	+0.02	77.4	−1.2	95	1	88	62	11	66	29		63	55	54	1.66	−0.1	9	6,226	se.	45	s.	11	16	11	4	3.8		
Santa Fe	7,013	57	66	23.34	29.86	− .03	67.8	+0.8	88	3	79	52	31	57	29		54	46	56	0.82	−1.5	8	4,762	e.	30	s.	13	6	25	0	4.6		
Flagstaff	6,968	8	57	23.46	29.91	+ .07	61.1	−1.7	87	2	75	36	19	47	44					2.83		11		nw.	33	w.	31	14	16	1			
Phoenix	1,108	76	81	28.69	29.81	+ .02	84.6	−4.4	113	2	98	62	18	71	36		69	61	51	3.47	+2.5	6	3,500	e.	25	sw.	10	21	7	3	2.8		
Yuma	141	9	54	29.64	29.78	+ .02	86.4	−3.7	117	2	101	61	17	72	41		73	67	57	0.53	+0.2	4	4,173	w.	36	se.	4	23	7	1	2.4		
Independence	3,910	11	42	25.96	29.92	+ .11	73.2	−3.2	100	4	88	46	16	58	38		53	36	32	0.05	0.0	2	4,354	se.	26	se.	27	21	9	1	2.2		
Needles	488	4		29.28	29.77		89.0		119	3	105	60	18	73	45					2.85		3						19	2	10	2.8		
Middle Plateau.							**69.5**	**−2.1**											**40**	**0.62**	**−0.1**									**2.8**		
Reno	4,532	74	81	25.48	29.90	+0.06	67.7	+0.7	95	28	84	40	17	51	41		50	36	38	T.	−0.2	0	5,180	w.	34	w.	15	23	7	1	1.8		
Tonopah	6,090	12	20	24.10	29.90		68.6		91	4	80	46	17	57	29		50	34	32	0.23	−0.2	3	5,837	se.	38	se.	29	23	8	0	1.7		
Winnemucca	4,344	18	56	25.63	29.96	+ .08	65.7	−5.1	94	25	84	33	21	48	51		48	34	41	0.37	+0.2	3	4,152	ne.	40	sw.	14	21	9	1	2.3		
Modena	5,479	10	43	24.66	29.91	+ .05	66.5	−2.1	95	3	82	39	18	51	44		50	37	44	1.26	−0.6	11	8,592	sw.	46	n.	11	14	8	9	4.1		
Salt Lake City	4,360	163	203	25.62	29.90	− .01	72.4	−3.1	96	4	84	50	22	61	29		55	42	37	0.61	−0.2	3	5,933	nw.	32	sw.	13	19	9	3	2.8		
Grand Junction	4,602	82	96	25.40	29.92	+ .02	75.0	−1.1	99	2	88	54	5	62	37		56	43	38	1.28	+0.2	6	4,814	se.	43	sw.	5	13	14	4	4.0		
Northern Plateau.							**66.8**	**−3.6**											**48**	**0.75**	**+0.4**									**4.2**		
Baker	3,471	48	53	26.47	30.01	+0.06	61.2	−3.7	91	25	75	36	20	47	41		51	43	59	0.92	+0.5	9	4,388	se.	29	se.	14	11	7	13	5.1		
Boise	2,739	78	86	27.16	29.98	+ .05	67.3	−4.5	94	31	81	39	20	54	39		53	42	47	0.48	+0.3	7	3,782	se.	26	sw.	1	18	9	4	3.2		
Lewiston	757	40	48	29.16	29.96	+ .01	70.4	−3.1	100	1	84	49	21	57	42					1.17	+0.8	10	2,353	e.	27	nw.	8	11	9	11	4.8		
Pocatello	4,477	60	68	25.49	29.93	+ .01	66.2	−4.3	91	1	80	40	22	52	43		50	37	39	0.41	−0.2	5	6,420	se.	38	s.	8	20	10	1	2.9		
Spokane	1,929	101	110	27.95	29.97	+ .02	65.9	−2.0	94	25	78	44	12	53	38		53	43	51	0.55	+0.1	8	4,469	sw.	27	nw.	11	12	6	13	5.5		
Walla Walla	991	57	65	28.92	29.98	+ .02	70.0	−3.8	97	24	82	45	20	58	35		56	44	44	0.99	+0.5	7	3,503	s.	20	w.	26	16	9	6	3.7		
North Pacific Coast Region.							**62.2**	**+0.3**											**76**	**1.74**	**+1.0**									**5.3**		
North Head	211	11	56	29.85	30.07	+0.04	57.9	0.0	88	30	61	51	25	55	28		56	55	92	1.55	+1.0	14	11,887	nw.	44	se.	14	8	3	20	6.7		
North Yakima	1,071	4					67.8		94	24	84	45	17	52	44					0.30		7		nw.				15	7	9			
Port Angeles	29	8	53	30.06	30.09		58.2		80	30	66	43	20	50	25					2.75	+2.1	11	3,948	nw.	27	nw.	18	13	5	13	5.0		
Seattle	125	215	250	29.94	30.07	+ .07	62.6	−0.5	84	31	70	48	20	55	26		57	53	75	1.12	+0.6	8	5,655	s.	36	sw.	1	8	13	10	5.6		
Tacoma	213	113	120	29.84	30.07	+ .05	62.6	−0.4	86	31	72	47	20	54	29		57	52	72	0.69	0.0	10	3,683	n.	24	w.	1	8	11	12	6.0		
Tatoosh Island	109	7	57	29.97	30.07	+ .07	55.1	−0.2	70	31	59	46	13	51	19		54	53	93	4.72	+2.6	10	8,058	s.	48	ne.	1	8	9	14	5.9		
Medford	1,425	4																														
Portland, Oreg.	153	68	106	29.88	30.03	+ .02	67.4	+1.5	94	31	77	48	27	57	35		58	52	63	0.31	−0.3	7	4,481	nw.	24	s.	1	11	6	14	5.5		
Roseburg	510	9	57	29.49	30.04	+ .04	67.4	+1.2	100	30	82	46	20	53	48		56	49	62	1.05	+0.7	3	2,643	n.	18	n.	22	19	10	2	2.5		
Middle Pacific Coast Region.							**66.0**	**+1.1**											**58**	**0.06**	**0.0**									**0.3**		
Eureka	62	73	89	29.97	30.04	+0.04	56.6	+0.08	69	30	62	48	28	51	18		54	52	87	0.21	+0.1	2	4,738	sw.	36	n.	19	12	13	6	4.7		
Mount Tamalpais	2,375	11	18	27.52	29.96	+ .03	68.6	+2.7	94	29	76	45	13	61	24		52	38	42	0.00	0.0	0	11,354	nw.	56	sw.	14	26	2	3	1.7		
Point Reyes Light	490	7	18	29.42	29.94		55.1	+0.6	65	29	59	49	3	51	15					0.00		0	13,140	nw.	59	nw.	4	3	6	22	7.9		
Red Bluff	332	50	56	29.52	29.86	.00	79.8	−1.2	110	29	95	54	14	65	41		60	42	32	0.12	+0.1	2	3,974	se.	23	n.	21	28	2	1	1.0		
Sacramento	69	106	117	29.82	29.89	+ .04	74.0	+1.9	104	29	90	52	12	58	43		60	49	50	T.	0.0	0	6,030	s.	26	s.	13	27	3	1	0.8		
San Francisco	155	209	213	29.78	29.95	+ .03	60.9	+2.9	76	29	68	52	8	54	22		55	53	82	0.00	0.0	0	9,039	sw.	34	sw.	10	22	7	2	2.2		
San Jose	141	12	110	29.81	29.96		67.1	+0.4	95	29	82	47	5	52	41					0.00	0.0	0	4,581	nw.	30	sw.	13	27	4	0	1.7		
South Pacific Coast Region.							**71.7**	**+1.2**											**65**	**0.04**	**0.0**									**2.5**		
Fresno	327	89	98	29.52	29.87	+0.05	79.2	−2.0	107	29	95	53	17	63	37		59	43	34	0.00	0.0	0	6,060	nw.	26	nw.	16	29	1	1	0.8		
Los Angeles	338	159	191	29.56	29.92	+ .04	71.7	+3.1	100	3	80	57	23	63	29		63	60	73	0.03	0.0	2	4,075	sw.	17	se.	4	21	8	2	2.9		
San Diego	87	62	70	29.83	29.92	+ .03	69.8	+1.1	82	3	75	59	18	65	14		65	62	81	0.11	+0.1	3	4,901	nw.	20	s.	4	19	8	4	3.6		
San Luis Obispo	201	32	40	29.74	29.96	+ .02	66.0	+2.5	91	28	78	48	5	54	35		57	53	74	0.01	0.0	1	2,611	nw.	17	w.	17	22	6	3	2.8		
West Indies.																																
San Juan, Porto Rico	82	8	54	29.93	30.01	+0.04	80.6		89	10	85	72	5	76	14					2.78	−4.6	12	10,100	ne.	42	ne.	2	18	11	2	3.6		
Panama Canal.																																
Balboa Heights	118	7	97	29.71	29.83	−0.01	80.8	+0.7	91	10	87	72	29	75	17		76	75	89	3.84	−4.0	14	5,698	nw.	36	nw.	1	0	19	12	7.1		
Colon	36	30	97	29.80	29.84	− .01	80.0	+0.3	86	19	84	73	26	76	11		77	76	87	18.85	+3.8	26	7,128	n.	27	sw.	3	0	4	27	8.8		
Alaska.																																
Juneau							**54.4**		73	2	60	45	2	49	28		52	51	92	11.53		24	2,711	se.	14	se.	18	2	3	26	8.8		

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during August, 1918, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated. 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex.	23-24	8:58 p. m.	5:50 a. m.	2.20	9:13 p. m.	9:26 p. m.	0.02	0.29	0.45	0.58											
					10:17 p. m.	11:04 p. m.	0.72	0.09	0.31	0.45	0.56	0.63	0.77	0.88	0.99	1.06	1.09				
		7:05 a. m.	9:40 a. m.	0.80	7:23 a. m.	8:07 a. m.	0.01	0.08	0.11	0.24	0.35	0.41	0.47	0.50	0.64	0.75					
Albany, N. Y.	31	6:01 p. m.	D. N. a. m.	1.35	7:22 p. m.	7:37 p. m.	0.23	0.05	0.31	0.64											
Alpena, Mich.	22	8:00 a. m.	11:15 a. m.	1.00	9:49 a. m.	10:12 a. m.	0.11	0.17	0.42	0.57	0.70	0.74									
Amarillo, Tex.	7-8	2:35 p. m.	D. N. a. m.	1.61	4:20 p. m.	4:50 p. m.	0.00	0.13	0.33	0.66	0.82	0.89	0.98								
Anniston, Ala.	10	3:34 p. m.	6:20 p. m.	0.81	3:36 p. m.	4:06 p. m.	0.01	0.29	0.41	0.55	0.62	0.68	0.74								
	31	12:08 p. m.	12:58 p. m.	0.62	12:21 p. m.	12:40 p. m.	0.01	0.14	0.38	0.54	0.58										
Asheville, N. C.	18	2:10 p. m.	7:10 p. m.	2.27	2:16 p. m.	2:36 p. m.	0.01	0.48	1.21	1.71	1.80										
Atlanta, Ga.	27	4:05 p. m.	7:15 p. m.	0.90	5:11 p. m.	5:26 p. m.	0.03	0.40	0.73	0.83											
	31	12:15 p. m.	1:25 p. m.	0.93	12:47 p. m.	1:22 p. m.	0.02	0.10	0.18	0.34	0.52	0.59	0.75	0.91							
		1:45 p. m.	3:30 p. m.	0.65	2:11 p. m.	2:26 p. m.	0.03	0.21	0.46	0.56											
Atlantic City, N. J.	12			0.43																	
Augusta, Ga.	2-3	8:50 p. m.	D. N. a. m.	1.14	11:36 p. m.	12:06 a. m.	0.42	0.10	0.18	0.23	0.31	0.43	0.55					0.42			
Baker, Oreg.	19			0.20																	
Baltimore, Md.	31	4:16 p. m.	7:20 p. m.	1.27	4:40 p. m.	5:04 p. m.	0.04	0.52	0.72	0.95	1.13	1.18						0.13			
Bentonville, Ark.	15	1:45 p. m.	2:30 p. m.	1.02	1:51 p. m.	2:30 p. m.	0.01	*	*	*	*	*	*	*	1.01						
	23	2:30 p. m.	3:15 p. m.	0.64	2:35 p. m.	3:00 p. m.	0.01	0.18	0.41	0.49	0.54	0.60									
	24	9:40 a. m.	12: noon	0.79	11:11 a. m.	11:53 a. m.	0.14	0.15	0.27	0.32	0.36	0.43	0.50	0.55	0.63	0.66					
Binghamton, N. Y.	29			0.86																	
Birmingham, Ala.	15			0.45														0.58			
Bismarck, N. Dak.	19	2:00 p. m.	3:15 p. m.	0.68	2:37 p. m.	3:00 p. m.	0.01	0.13	0.27	0.34	0.55	0.66						0.44			
	21	9:08 p. m.	9:58 p. m.	0.96	9:17 p. m.	9:35 p. m.	0.01	0.32	0.52	0.79	0.86										
Block Island, R. I.	11			0.65																	
Boise, Idaho.	17			0.23														0.28			
Boston, Mass.	9			0.71														0.11			
Buffalo, N. Y.	8-9	9:30 p. m.	5:15 a. m.	1.28	9:47 p. m.	10:11 p. m.	0.02	0.10	0.24	0.40	0.45	0.52						0.32			
Burlington, Vt.	31			1.60																	
Cairo, Ill.	9			0.22														0.70			
Canton, N. Y.	7	8:32 p. m.	9:20 p. m.	0.58	8:34 p. m.	8:57 p. m.	0.01	0.13	0.25	0.36	0.49	0.56						0.22			
	8-9	D. N. p. m.	D. N. a. m.	0.81	11:59 p. m.	12:13 a. m.	0.28	0.13	0.40	0.52											
Charles City, Iowa.	1	5:07 a. m.	10:10 a. m.	0.74	5:09 a. m.	5:32 a. m.	0.01	0.13	0.25	0.32	0.49	0.62									
	16	1:12 a. m.	6:43 a. m.	2.61	3:39 a. m.	4:31 a. m.	0.93	0.07	0.15	0.28	0.35	0.37	0.38	0.44	0.61	0.83	1.12	1.17			
Charleston, S. C.	28	11:01 a. m.	2:00 p. m.	1.37	11:10 a. m.	11:49 a. m.	0.03	0.07	0.10	0.14	0.26	0.56	0.89	1.04	1.09						
Charlotte, N. C.	31	2:58 p. m.	4:03 p. m.	0.68	3:25 p. m.	3:57 p. m.	0.01	0.08	0.14	0.24	0.36	0.54	0.58	0.67							
Chattanooga, Tenn.	30			0.38														0.37			
Cheyenne, Wyo.	14	8:15 p. m.	9:45 p. m.	0.79	8:30 p. m.	8:49 p. m.	0.03	0.07	0.26	0.51	0.70										
Chicago, Ill.	10			0.25														0.25			
Cincinnati, Ohio.	30	1:58 p. m.	5:32 p. m.	1.33	2:49 p. m.	3:09 p. m.	0.19	0.11	0.47	0.60	0.69										
Cleveland, Ohio.	8			1.51														0.65			
Columbia, Mo.	9	6:09 p. m.	D. N. p. m.	2.21	7:02 p. m.	7:54 p. m.	0.02	0.15	0.47	0.90	1.18	1.21	1.43	1.68	1.77	1.91	2.02	2.09			
	13	1:50 p. m.	3:22 p. m.	1.22	1:56 p. m.	2:38 p. m.	0.01	0.16	0.40	0.55	0.69	0.87	0.90	0.96	1.06	1.11					
	19	8:48 a. m.	1:58 p. m.	1.58	9:16 a. m.	9:57 a. m.	0.07	0.13	0.43	0.76	0.96	1.07	1.17	1.24	1.28	1.31					
	23	11:35 a. m.	1:30 p. m.	1.08	11:35 a. m.	12:20 p. m.	0.00	0.09	0.16	0.26	0.39	0.49	0.62	0.77	0.88	0.95					
Columbia, S. C.	15	8:02 p. m.	D. N. p. m.	1.76	8:05 p. m.	8:55 p. m.	0.01	0.13	0.27	0.41	0.64	0.90	1.11	1.34	1.44	1.56	1.68				
	18	9:30 p. m.	10:40 p. m.	0.70	9:43 p. m.	10:07 p. m.	0.03	0.17	0.29	0.42	0.52	0.58									
Columbus, Ohio.	12	12:39 p. m.	1:50 p. m.	0.91	12:45 p. m.	1:42 p. m.	0.02	0.13	0.30	0.30	0.34	0.38	0.49	0.55	0.64	0.67	0.77	0.89			
Concord, N. H.	8	3:55 p. m.	4:20 p. m.	0.55	3:58 p. m.	4:18 p. m.	T.	0.07	0.21	0.38	0.54										
	8	8:37 p. m.	9:57 p. m.	0.74	8:41 p. m.	9:10 p. m.	0.02	0.16	0.35	0.39	0.49	0.59	0.66	0.67							
Concordia, Kans.	22	6:32 p. m.	8:48 p. m.	0.74	6:41 p. m.	7:01 p. m.	0.05	0.18	0.48	0.57	0.62										
Corpus Christi, Tex.	27			0.09														0.07			
Dallas, Tex.	24	3:01 p. m.	8:34 p. m.	2.41	3:39 p. m.	3:58 p. m.	0.01	0.22	0.56	0.77	0.98										
					4:56 p. m.	5:24 p. m.	1.06	0.11	0.31	0.39	0.51	0.60	0.65								
Davenport, Iowa.	15			0.87														0.43			
Dayton, Ohio.	26			0.97														0.41			
Del Rio, Tex.	1			0.21														0.21			
Denver, Colo.	6			0.58														0.32			
Des Moines, Iowa.	17-18	6:27 p. m.	D. N. a. m.	1.40	7:10 p. m.	7:35 p. m.	0.07	0.14	0.36	0.62	0.78	0.85									
Detroit, Mich.	11			0.41														0.27			
Devils Lake, N. Dak.	19			0.83														0.30			
Dodge City, Kans.	8			0.49														*			
Drexel, Nebr.	11			0.21														0.14			
Dubuque, Iowa.	16	9:00 p. m.	8:15 a. m.	4.46	9:35 p. m.	10:25 p. m.	0.03	0.13	0.31	0.49	0.65	0.70	0.73	0.79	0.84	0.87	0.90				
	17				10:25 p. m.	11:15 p. m.	.....	0.93	0.94	1.01	1.06	1.20	1.30	1.33	1.43	1.60	1.79				
					11:15 p. m.	12:05 a. m.	.....	2.07	2.37	2.57	2.78	2.97	3.05	3.18	3.30	3.42	3.49				
					12:05 a. m.	12:20 a. m.	.....	3.61	3.74	3.82											
Duluth, Minn.	9-10			0.56														0.54			
Eastport, Me.	5			0.47														0.26			
Elkins, W. Va.	12	4:26 p. m.	D. N. p. m.	1.23	4:43 p. m.	5:33 p. m.	0.01	0.28	0.31	0.32	0.35	0.38	0.60	0.76	0.86	0.96	1.01				
Ellendale, N. Dak.	3	6:10 p. m.	9:35 p. m.	1.66	7:47 p. m.	8:56 p. m.	0.05	0.11	0.24	0.38	0.48	0.52	0.54	0.54	0.57	0.63	1.01	1.39			
El Paso, Tex.	13			0.40														0.20			
Erie, Pa.	28			0.58														0.39			
Escanaba, Mich.	5			0.52														0.38			
Eureka, Cal.	14			0.20														0.06			
Evansville, Ind.	17	3:03 p. m.	4:30 p. m.	0.67	3:23 p. m.	3:37 p. m.	0.01	0.14	0.37	0.57											
Flagstaff, Ariz.	7			0.74														*			
Fort Smith, Ark.	30			0.52														0.29			
Fort Wayne, Ind.	30			0.66														0.45			
Fort Worth, Tex.	23			0.25														0.25			
Fresno, Cal.	‡			‡														‡			
Galveston, Tex.	23	6:56 a. m.	10:50 a. m.	1.75	8:01 a. m.	8:50 a. m.	0.03	0.11	0.26	0.40	0.57	0.75	0.94	1.17	1.37	1.53	1.64				
Grand Haven, Mich.	13			0.32														0.32			
Grand Junction, Colo.	5	6:01 p. m.	D. N. p. m.	0.70	6:13 p. m.	6:33 p. m.	0.02	0.20	0.44	0.55	0.61										
Grand Rapids, Mich.	30-31			0.39														0.22			
Green Bay, Wis.	1			0.48														0.48			
Greenville, S. C.	10			0.50														0.49			
Hannibal, Mo.	23	11:13 a. m.	3:35 p. m.	0.94	12:41 p. m.	1:03 p. m.	0.15	0.14	0.30	0.37	0.48	0.55									
	29	7:35 p. m.	10:15 p. m.	1.30	7:41 p. m.	8:04 p. m.	0.02	0.15	0.56	0.89	1.04	1.09									
	30	1:50 p. m.	4:42 p. m.	0.74	1:54 p. m.	2:10 p. m.	0.01	0.20	0.44	0.56	0.60										
Harrisburg, Pa.	14			0.88														0.54			
Hartford, Conn.	14	4:40 p. m.	5:05 p. m.	0.54	4:40 p. m.	4:57 p. m.	0.00	0.22	0.34	0.49	0.54										
	31	8:10 p. m.	D. N. a. m. §	1.07	11:23 p. m.	11:43 p. m.	0.01	0.43	0.64	0.69	0.76										
Hatteras, N. C.	2	D. N. a. m.	8:15 a. m.	1.18	5:40 a. m.	6:02 a. m.	0.41	0.08	0.20	0.42	0.55	0.59									
Havre, Mont.	17	4:55 p. m.	6:16 p. m.	0.71	5:01 p. m.	5:13 p. m.	0.03	0.18	0.42	0.59											
Helena, Mont.	11			0.21														0.14			
Houghton, Mich.	20			0.37														0.29			
Houston, Tex.	24	10:19 a. m.	11:30 p. m.	0.68	10:45 a. m.	11:07 a. m.	0.01	0.26	0.36	0.41	0.48	0.52									
Huron, S. Dak.	4	2:05 a. m.	D. N. a. m.	0.64	2:15 a. m.	2:25 a. m.	0.02	0.34	0.61												
Independence, Cal.	13			0.04														*			
Indianapolis, Ind.	30			0.74														0.51			
Iola, Kans.	30			0.34														0.24			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month. § Sept. 1.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during August, 1918, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.												
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Jacksonville, Fla.	10			0.38														0.38			
Kalispell, Mont.	2			0.21														0.13			
Kansas City, Mo.	16	7:22 p. m.	8:15 p. m.	0.63	7:25 p. m.	7:43 p. m.	0.01	0.13	0.28	0.50	0.60										
Keokuk, Iowa.	10–11	11:32 p. m.	D. N. a. m.	0.86	11:55 p. m.	12:17 a. m.	0.05	0.20	0.29	0.44	0.59	0.67									
	18	D. N. a. m.	8:25 a. m.	1.03	3:43 p. m.	3:53 p. m.	0.00	0.18	0.30	0.41	0.67	0.75									
Key West, Fla.	21			0.90														0.49			
Knoxville, Tenn.	19	2:05 p. m.	2:45 p. m.	0.72	2:13 p. m.	2:28 p. m.	0.03	0.15	0.32	0.66											
	31	6:52 a. m.	7:55 a. m.	0.74	7:07 a. m.	7:34 a. m.	0.04	0.19	0.39	0.50	0.54	0.62	0.68								
La Crosse, Wis.	7	4:00 p. m.	4:51 p. m.	1.18	4:08 p. m.	4:22 p. m.	0.01	0.66	0.85	1.02											
Lander, Wyo.	8			0.12														0.12			
Lansing, Mich.	28			0.42														0.39			
Lewiston, Idaho.	19			0.59														0.16			
Lexington, Ky.	27	2:35 p. m.	3:25 p. m.	0.62	2:41 p. m.	3:00 p. m.	0.01	0.14	0.27	0.47	0.57										
Lincoln, Nebr.	7			0.33														0.20			
Little Rock, Ark.	20			0.30														0.29			
Los Angeles, Cal.	10			0.02														0.01			
Louisville, Ky.	26			1.15														0.67			
Ludington, Mich.	12			0.37														0.33			
Lynchburg, Va.	25			0.45														0.42			
Macon, Ga.	16	6:30 p. m.	7:23 p. m.	0.88	6:05 p. m.	6:22 p. m.	0.01	0.13	0.32	0.74	0.79										
Madison, Wis.	13			1.08														0.61			
Marquette, Mich.	28			1.02														*			
Memphis, Tenn.	19–20	8:30 p. m.	D. N. a. m.	0.85	8:37 p. m.	8:55 p. m.	0.02	0.27	0.47	0.53	0.59										
Meridian, Miss.	27	6:20 a. m.	12:12 p. m.	3.53	10:27 a. m.	12:04 p. m.	0.52	0.06	0.12	0.26	0.36	0.46	0.54	0.63	0.72	0.80	1.00	1.51	2.50	3.00	
Miami, Fla.	5			0.46														0.26			
Milwaukee, Wis.	30			0.23														0.16			
Minneapolis, Minn.	28	7:42 a. m.	9:10 a. m.	0.74	7:47 a. m.	8:18 a. m.	0.01	0.14	0.26	0.32	0.40	0.52	0.65	0.67							
	10	2:15 p. m.	7:15 p. m.	2.22	3:23 p. m.	4:30 p. m.	0.24	0.14	0.33	0.48	0.54	0.67	0.91	1.22	1.43	1.57	1.65	1.75	1.85		
	20	1:11 p. m.	5:37 p. m.	3.31	1:15 p. m.	3:14 p. m.	0.01	0.07	0.19	0.41	0.49	0.62	0.87	1.10	1.24	1.30	1.35	1.36	1.82	2.55	2.89
Mobile, Ala.	26	6:15 a. m.	9:48 a. m.	1.37	6:24 a. m.	6:57 a. m.	0.01	0.21	0.28	0.31	0.46	0.77	1.08	1.16							
	27	4:40 a. m.	8:40 a. m.	1.03	4:58 a. m.	5:42 a. m.	0.01	0.23	0.32	0.32	0.32	0.33	0.33	0.45	0.82	0.96					
	28	10:45 a. m.	1:25 p. m.	0.70	10:52 a. m.	11:09 a. m.	0.01	0.23	0.44	0.56	0.61										
	30	4:02 p. m.	5:47 p. m.	0.58	4:16 p. m.	4:29 p. m.	0.01	0.23	0.48	0.57											
Modena, Utah.	6			0.34														0.34			
Montgomery, Ala.	2	D. N. a. m.	5:19 a. m.	1.12	4:08 a. m.	4:49 a. m.	0.12	0.06	0.14	0.19	0.37	0.38	0.48	0.68	0.97	0.99					
	31	1:35 p. m.	3:50 p. m.	1.69	2:12 p. m.	2:39 p. m.	0.28	0.09	0.28	0.40	0.74	1.02	1.11								
Moorhead, Minn.	9	5:05 p. m.	6:10 p. m.	0.85	5:30 p. m.	5:48 p. m.	0.06	0.22	0.51	0.67	0.72										
	12	6:15 a. m.	8:25 a. m.	1.48	6:55 a. m.	7:50 a. m.	0.05	0.06	0.22	0.55	0.73	0.78	0.81	0.82	0.89	1.09	1.19	1.33			
	22	2:00 a. m.	2:45 a. m.	0.65	2:04 a. m.	2:19 a. m.	0.01	0.11	0.35	0.63											
Mount Tamalpais, Cal.	‡			‡																	
Nantucket, Mass.	11			0.92														0.25			
Nashville, Tenn.	18	2:15 p. m.	3:35 p. m.	0.87	2:21 p. m.	2:50 p. m.	0.01	0.12	0.26	0.45	0.60	0.71	0.76								
New Haven, Conn.	9	11:40 a. m.	12:50 p. m.	1.03	11:49 a. m.	12:23 p. m.	T.	0.14	0.47	0.64	0.74	0.77	0.86	0.95							
New Orleans, La.	19	12:24 p. m.	1:07 p. m.	1.09	12:31 p. m.	12:52 p. m.	0.01	0.21	0.55	0.87	1.03	1.06									
	21	3:10 p. m.	D. N. p. m.	1.99	4:01 p. m.	4:58 p. m.	0.18	0.21	0.39	0.54	0.58	0.63	0.66	0.79	0.99	1.12	1.25	1.42			
New York, N. Y.	11			0.51														0.37			
Norfolk, Va.	18			0.71														0.35			
Northfield, Vt.	8–9			3.22																	
North Head, Wash.	8			0.16														0.11*			
North Platte, Nebr.	14			0.88														0.53			
Oklahoma, Okla.	24			1.11														0.47			
Omaha, Nebr.	10	5:28 p. m.	7:05 p. m.	0.62	5:49 p. m.	6:20 p. m.	0.05	0.06	0.12	0.21	0.31	0.42	0.51	0.55							
Oswego, N. Y.	8			0.76														0.25			
Palestine, Tex.	31	9:10 a. m.	10:45 a. m.	1.06	9:31 a. m.	10:01 a. m.	0.07	0.10	0.26	0.45	0.65	0.78	0.86								
Parkersburg, W. Va.	10	1:28 p. m.	1:54 p. m.	0.59	1:28 p. m.	1:39 p. m.	0.00	0.24	0.55	0.58											
	26	1:42 p. m.	3:18 p. m.	1.07	1:42 p. m.	2:18 p. m.	0.00	0.20	0.57	0.57	0.57	0.63	0.82	0.95	0.99						
Pensacola, Fla.	1	5:25 p. m.	6:50 p. m.	1.03	6:24 p. m.	6:45 p. m.	0.12	0.15	0.27	0.55	0.80	0.91									
	10	2:20 p. m.	6:05 p. m.	1.91	2:29 p. m.	3:14 p. m.	0.01	0.18	0.65	0.91	1.00	1.18	1.34	1.50	1.61	1.67	1.70				
	11	6:10 a. m.	8:05 a. m.	3.02	6:16 a. m.	7:26 a. m.	0.01	0.20	0.59	0.83	0.93	1.25	1.56	1.72	1.85	2.09	2.37	2.69	2.92		
	19	8:23 a. m.	9:25 a. m.	1.58	8:24 a. m.	9:05 a. m.	0.01	0.27	0.53	0.79	1.06	1.22	1.33	1.45	1.52	1.56					
	20	11:55 a. m.	1:25 p. m.	1.50	12:14 p. m.	1:15 p. m.	0.03	0.18	0.40	0.61	0.76	0.88	1.00	1.05	1.14	1.26	1.33	1.43	1.47		
	26	8:55 a. m.	12:20 p. m.	1.04	9:24 a. m.	9:45 a. m.	0.07	0.15	0.41	0.65	0.77	0.82									
	28	11:27 a. m.	3:40 p. m.	1.13	11:37 a. m.	11:55 a. m.	0.01	0.14	0.45	0.76	0.83										
Peoria, Ill.	13	9:45 p. m.	12:00 p. m.	1.11	10:28 p. m.	10:49 p. m.	0.15	0.16	0.33	0.46	0.66	0.70									
	15	5:30 a. m.	9:50 a. m.	1.44	6:00 a. m.	6:17 a. m.	0.09	0.25	0.53	0.87	0.95										
	30	4:20 p. m.	6:40 p. m.	0.83	4:33 p. m.	4:53 p. m.	0.02	0.15	0.33	0.58	0.70										
Philadelphia, Pa.	12	3:45 p. m.	5:50 p. m.	1.59	4:10 p. m.	4:50 p. m.	0.13	0.16	0.29	0.48	0.72	0.93	1.13	1.30	1.38						
Phoenix, Ariz.	4–5	10:35 p. m.	12:10 a. m.	0.78	10:40 p. m.	11:17 p. m.	0.01	0.05	0.14	0.36	0.49	0.55	0.58	0.66	0.70						
	6	5:50 a. m.	9:35 a. m.	1.92	6:03 a. m.	7:56 a. m.	0.05	0.22	0.29	0.31	0.38	0.44	0.50	0.57	0.60	0.70	0.83	1.05	1.32	1.58	1.79
Pierre, S. Dak.	27	11:00 p. m.	11:50 p. m.	0.84	11:10 p. m.	11:30 p. m.	0.01	0.32	0.52	0.70	0.78										
Pittsburgh, Pa.	30	10:15 a. m.	12:18 p. m.	0.93	10:57 p. m.	11:19 a. m.	0.05	0.15	0.38	0.58	0.72	0.77									
Pocatello, Idaho.	14			0.24														0.15			
Point Reyes Light, Cal.	‡			‡														‡			
Port Angeles, Wash.	15			1.00														0.42			
Port Huron, Mich.	23			0.32														0.30			
Portland, Me.	14	3:26 p. m.	5:35 p. m.	0.66	3:48 p. m.	4:18 p. m.	0.03	0.21	0.23	0.23	0.39	0.54	0.59								
Portland, Oreg.	15			0.09														0.05			
Providence, R. I.	9			0.65														0.64			
Pueblo, Colo.	7			0.12														0.08			
Raleigh, N. C.	18	4:15 p. m.	7:10 p. m.	0.86	4:49 p. m.	5:21 p. m.	0.02	0.12	0.25	0.34	0.39	0.43	0.50	0.58							
	31	5:32 p. m.	7:16 p. m.	0.64	5:39 p. m.	5:58 p. m.	T.	0.20	0.27	0.43	0.53										
Rapid City, S. Dak.	19			1.19														0.64			
Reading, Pa.	12	2:40 p. m.	3:47 p. m.	0.80	3:16 p. m.	3:32 p. m.	0.07	0.11	0.44	0.70	0.73										
	25	3:55 p. m.	5:45 p. m.	0.91	4:01 p. m.	4:25 p. m.	0.01	0.19	0.41	0.69	0.80	0.88									
Red Bluff, Cal.	15			0.11														0.10			
Reno, Nev.	1			T.														T.			
Richmond, Va.	10	6:25 p. m.	D. N. p. m.	0.72	6:25 p. m.	6:44 p. m.	0.00	0.13	0.31	0.45	0.52										
Rochester, N. Y.	11			0.48														0.44			
Roseburg, Oreg.	14			0.51														0.16			
Roswell, N. Mex.	9			0.59														0.27			
Sacramento, Cal.	1			T.														T.			
Saginaw, Mich.	28			1.00														0.56			
St. Joseph, Mo.	30	9:54 a. m.	5:25 p. m.	1.07	10:05 a. m.	10:29 a. m.	0.01	0.13	0.29	0.48	0.56	0.59									
St. Louis, Mo.	15	3:50 p. m.	5:00 p. m.	0.74	3:52 p. m.	4:05 p. m.	0.01	0.18	0.57	0.70											
	24	6:20 a. m.	6:00 p. m.	2.71	10:24 a. m.	11:44 a. m.	0.11	0.09	0.17	0.42	0.48	0.53	0.67	0.82	1.02	1.34	1.57	1.68	2.09		
St. Paul, Minn.	21–22	10:00 p. m.	12:15 a. m.	2.04	10:35 p. m.	11:36 p. m.	0.17	0.09	0.21	0.59	0.68	0.75	0.80	0.88	0.91	0.93	1.02	1.26	1.38		
	28	8:00 a. m.	8:42 a. m.	0.68	8:00 a. m.	8:20 a. m.	0.00	0.10	0.39	0.51	0.56										
Salt Lake City, Utah.	8			0.37														0.37			
San Antonio, Tex.	24	5:15 p. m.	7:39 p. m.	2.58	6:08 p. m.	6:52 p. m.	0.37	0.14	0.37	0.52	0.52	0.83	1.23	1.49	1.67	1.79	1.89				
San Diego, Cal.	15			0.07														0.06			
San Key, Fla.	21			1.10														0.49			
Sandusky, Ohio.	11			0.60														0.57			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during August, 1918, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.												
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Sandy Hook, N. J.	31			0.35														0.32			
San Francisco, Cal.	‡			‡														‡			
San Jose, Cal.	‡			‡														‡			
San Luis Obispo, Cal.	15			0.01														*			
Santa Fe, N. Mex.	14			0.24														0.22			
Sault Ste. Marie, Mich.	25			0.39														0.36			
Savannah, Ga.	2	11:42 a. m.	12:28 p. m.	0.92	11:42 a. m.	12:02 p. m.	0.00	0.18	0.53	0.79	0.91										
	19	3:06 p. m.	5:00 p. m.	0.82	3:59 p. m.	4:28 p. m.	0.10	0.12	0.13	0.20	0.49	0.66	0.71								
	30	4:42 p. m.	7:25 p. m.	1.00	4:44 p. m.	5:23 p. m.	0.01	0.11	0.21	0.27	0.37	0.51	0.64	0.74	0.80						
Scranton, Pa.	5			0.64														0.64			
Seattle, Wash.	8			0.35														0.19			
Sheridan, Wyo.	6			0.36														0.29			
Shreveport, La.	23	11:15 a. m.	11:55 a. m.	0.73	11:23 a. m.	11:37 a. m.	0.03	0.31	0.63	0.68											
Sioux City, Iowa.	7			0.96														0.58			
Spokane, Wash.	11			0.16														0.11			
Springfield, Ill.	18			0.44														0.37			
Springfield, Mo.	30	6:11 p. m.	11:14 p. m.	1.02	6:14 p. m.	6:28 p. m.	0.02	0.45	0.85	0.91											
Syracuse, N. Y.	9			0.78														0.23			
Tacoma, Wash.	18			0.19														0.15			
Tampa, Fla.	9	3:55 p. m.	5:30 p. m.	1.86	4:17 p. m.	5:10 p. m.	0.07	0.11	0.24	0.48	0.72	0.98	1.27	1.40	1.53	1.64	1.71	1.78			
	15	3:20 p. m.	4:10 p. m.	0.82	3:30 p. m.	3:58 p. m.	0.01	0.10	0.24	0.43	0.68	0.76	0.81								
	18	4:25 p. m.	6:15 p. m.	1.18	4:32 p. m.	4:57 p. m.	0.03	0.30	0.50	0.74	0.97	1.08									
Tatoosh Island, Wash.	1			0.49														0.40			
Taylor, Tex.	25			0.11														0.11			
Terre Haute, Ind.	19			0.70														0.58			
Thomasville, Ga.	16	4:07 p. m.	8:05 p. m.	2.53	4:15 p. m.	4:51 p. m.	0.05	0.40	0.65	0.90	1.07	1.21	1.33	1.42	1.46						
	19	12:00 m.	1:55 p. m.	0.57	12:02 p. m.	12:21 p. m.	0.01	0.18	0.38	0.45	0.53										
Toledo, Ohio	21	5:54 p. m.	7:00 p. m.	1.01	6:13 p. m.	6:49 p. m.	0.07	0.10	0.24	0.41	0.54	0.64	0.79	0.89	0.93						
Tonopah, Nev.	20			0.09														0.08			
Topeka, Kans.	22–23	5:06 p. m.	D. N. a. m.	1.54	5:49 p. m.	6:13 p. m.	0.04	0.20	0.46	0.50	0.56	0.64									
Trenton, N. J.	12	2:30 p. m.	5:35 p. m.	1.21	2:40 p. m.	3:07 p. m.	0.02	0.20	0.31	0.55	0.76	0.86	0.90								
Valentine, Nebr.	23			0.56														0.39			
Vicksburg, Miss.	19	1:07 p. m.	D. N. p. m.	3.44	1:09 p. m.	2:16 p. m.	0.01	0.09	0.17	0.29	0.65	1.01	1.54	2.02	2.31	2.59	2.85	3.11	3.27		
	21	5:10 p. m.	D. N. p. m.	0.99	5:22 p. m.	6:00 p. m.	0.05	0.06	0.13	0.31	0.45	0.53	0.59	0.65	0.68						
	26	12:01 p. m.	1:55 p. m.	0.74	12:07 p. m.	12:28 p. m.	0.01	0.16	0.37	0.54	0.67	0.72									
Walla Walla, Wash.	19			0.78														0.29			
Washington, D. C.	14			0.34														0.34			
Wausau, Wis.	21	6:18 a. m.	7:49 a. m.	0.57	6:47 a. m.	7:07 a. m.	0.04	0.20	0.39	0.44	0.50										
	28	2:40 p. m.	2:59 p. m.	0.69	2:44 p. m.	2:52 p. m.	0.01	0.51	0.68												
Wichita, Kans.	22–23	7:35 p. m.	D. N. a. m.	3.40	7:52 p. m.	8:57 p. m.	0.01	0.18	0.27	0.37	0.51	0.58	0.66	0.87	1.00	1.25	1.73	2.55	2.89		
Williston, N. Dak.	15	10:08 p. m.	4:50 p. m.	0.98	2:26 p. m.	2:55 p. m.	0.07	0.12	0.21	0.34	0.51	0.75	0.84								
	16–17	11:05 p. m.	D. N. a. m.	1.10	12:10 a. m	12:40 a. m.	0.07	0.15	0.42	0.55	0.72	0.81	0.92								
	21–22	6:12 p. m.	D. N. a. m.	0.67	6:22 p. m.	8:46 p. m.	0.03	0.08	0.13	0.20	0.39	0.50									
Wilmington, N. C.	24	6:25 p. m.	10:10 p. m.	4.49	2:51 p. m.	3:10 p. m.	2.22	0.06	0.35	0.50	0.60										
Winnemucca, Nev.	1			0.26														0.24			
Wytheville, Va.	15	1:22 p. m.	2:50 p. m.	0.65	1:28 p. m.	1:43 p. m.	0.01	0.16	0.40	0.56											
Yankton, S. Dak.	20			0.60														0.52			
Yellowstone Park, Wyo.	2–3			0.19														*			

* Self register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, August, 1918.*

Stations.	Altitude above M. S. L.* Jan. 1, 1916.	Pressure.			Temperature.						Precipitation.		
		Station reduced to mean of 24 hours.	Sea-level reduced to mean of 24 hours.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*Inches.*	*Inches.*	*Inches.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	125	29.83	29.96	0.00	56.1	−3.7	65.2	47.0	80	36	2.72	−1.36	
Sydney, C. B. I.	48	29.97	30.01	+0.06	62.4	−0.9	72.5	52.3	88	41	2.68	−0.94	
Halifax, N. S.	88	29.92	30.02	+ .06	62.2	−1.4	71.2	53.1	84	39	4.19	−0.16	
Yarmouth, N. S.	65	29.95	30.02	+ .05	59.6	−0.6	67.4	51.9	76	40	1.48	−2.53	
Charlottetown, P. E. I.	38	29.95	29.99	+ .05	62.6	−1.7	70.6	54.6	84	43	1.67	−2.07	
Chatham, N. B.	28	29.98	30.00	+0.07	62.7	−0.5	73.3	52.1	86	42	1.47	−2.57	
Father Point, Que.	20	29.94	29.96	+ .05	56.5	+0.9	65.1	47.9	78	40	1.77	−1.28	
Quebec, Que.	296	29.69	30.01	+ .08	63.1	0.0	72.1	54.1	82	42	2.82	−1.01	
Montreal, Que.	187	29.80	30.00	+ .05	67.1	+0.7	76.0	58.2	86	46	1.77	−1.80	
Stonecliffe, Ont.	489	29.38	29.98	+ .02	65.9	+2.7	79.4	52.4	94	36	4.34	+1.39	
Ottawa, Ont.	236	29.74	30.00	+0.04	68.0	+3.2	80.2	55.9	93	44	3.11	+0.08	
Kingston, Ont.	285	29.70	30.00	+ .02	68.5	+1.5	77.1	59.9	88	47	2.31	−0.07	
Toronto, Ont.	379	29.60	29.99	.00	70.6	+4.6	81.7	59.6	102	48	4.15	+1.39	
White River, Ont.	1,244	28.65	29.95	− .01	56.1	−0.3	71.0	41.3	83	28	2.50	−0.80	
Port Stanley, Ont.	592	29.39	30.02	+ .02	69.3	+3.4	79.2	59.5	86	48	2.36	−0.06	
Southampton, Ont.	656	29.30			67.1	+3.3	77.0	57.2	91	42	3.50	+1.25	
Parry Sound, Ont.	688	29.33	30.01	+0.03	68.4	+4.9	80.3	56.5	94	42	2.43	−0.29	
Port Arthur, Ont.	644	29.26	29.97	+ .01	62.6	+3.1	73.2	51.9	87	39	2.86	+0.11	
Winnipeg, Man.	760	29.08	29.89	− .05	65.3	+1.9	76.6	54.0	93	41	3.18	+0.51	
Minnedosa, Man.	1,690	28.12	29.90	− .04	62.2	+2.8	74.8	49.5	88	35	1.52	−0.58	
Qu'Appelle, Sask.	2,115	27.66	29.87	−0.06	62.4	+0.9	74.6	50.3	86	40	2.73	+1.09	
Medicine Hat, Alberta.	2,144	27.58	29.82	− .10	66.7	+1.0	82.0	51.5	96	35	1.83	+0.16	
Swift Current, Sask.	2,392	27.33	29.84	− .09	65.8	+1.8	80.5	51.1	96	36	1.26	−0.65	
Calgary, Alberta.	3,428	26.42	29.88	− .03	61.7	+2.3	77.9	45.5	93	34	2.54	+0.40	
Banff, Alberta.	4,521	25.41	29.92	+ .01	55.0	−1.3	68.6	41.4	87	32	3.18	+0.65	
Edmonton, Alberta.	2,150	27.59	29.83	−0.09	59.9	+1.1	72.4	47.4	83	36	3.00	+0.87	
Prince Albert, Sask.	1,450	28.32	29.85	− .07	61.7	+2.8	74.1	49.4	84	39	2.86	+0.71	
Battleford, Sask.	1,592	28.14	29.84	− .07	64.0	+1.4	78.6	49.3	89	38	0.86	−1.50	
Kamloops, B. C.	1,262	28.75	30.03	+ .12	65.6	−3.0	77.3	53.9	89	43	3.17	+2.08	
Victoria, B. C.	230	29.79	30.04	+ .03	59.5	+0.8	67.0	51.9	80	49	1.78	+1.18	
Barkerville, B. C.	4,180	25.76	30.06	+ .16	50.9	−5.4	60.3	41.5	74	32	4.30	+1.20	
Hamilton, Bermuda.	151	29.94	30.10	.00	79.5	−0.1	84.6	74.4	89	69	8.14	+2.06	

* See explanation of tables, in this REVIEW for January, 1918, p. 48.

Chart I. Hydrographs of Several Principal Rivers, August, 1918.

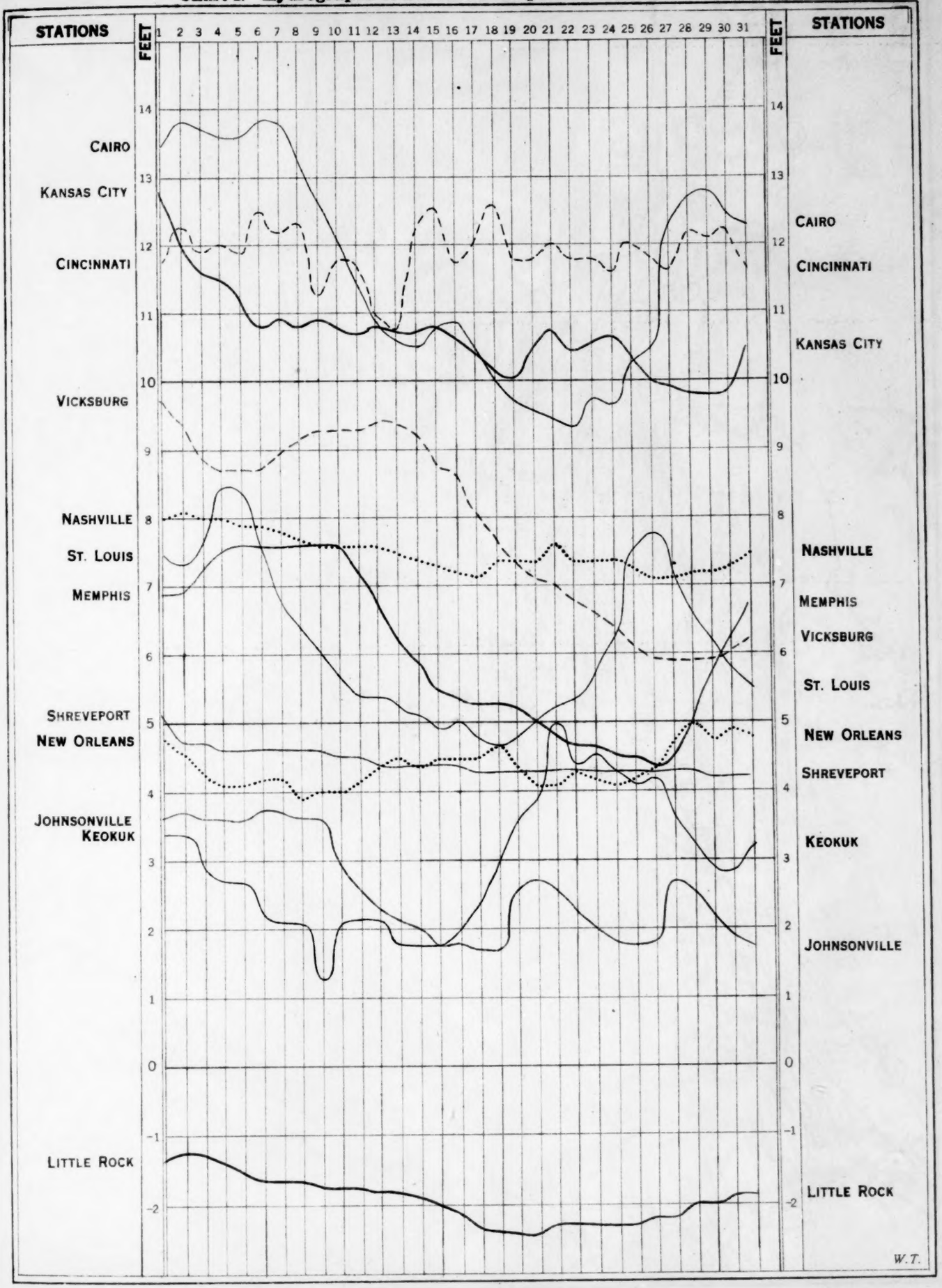


Chart II. Tracks of Centers of High Areas, August, 1918.

(Plotted by Charles A. Donnel.)

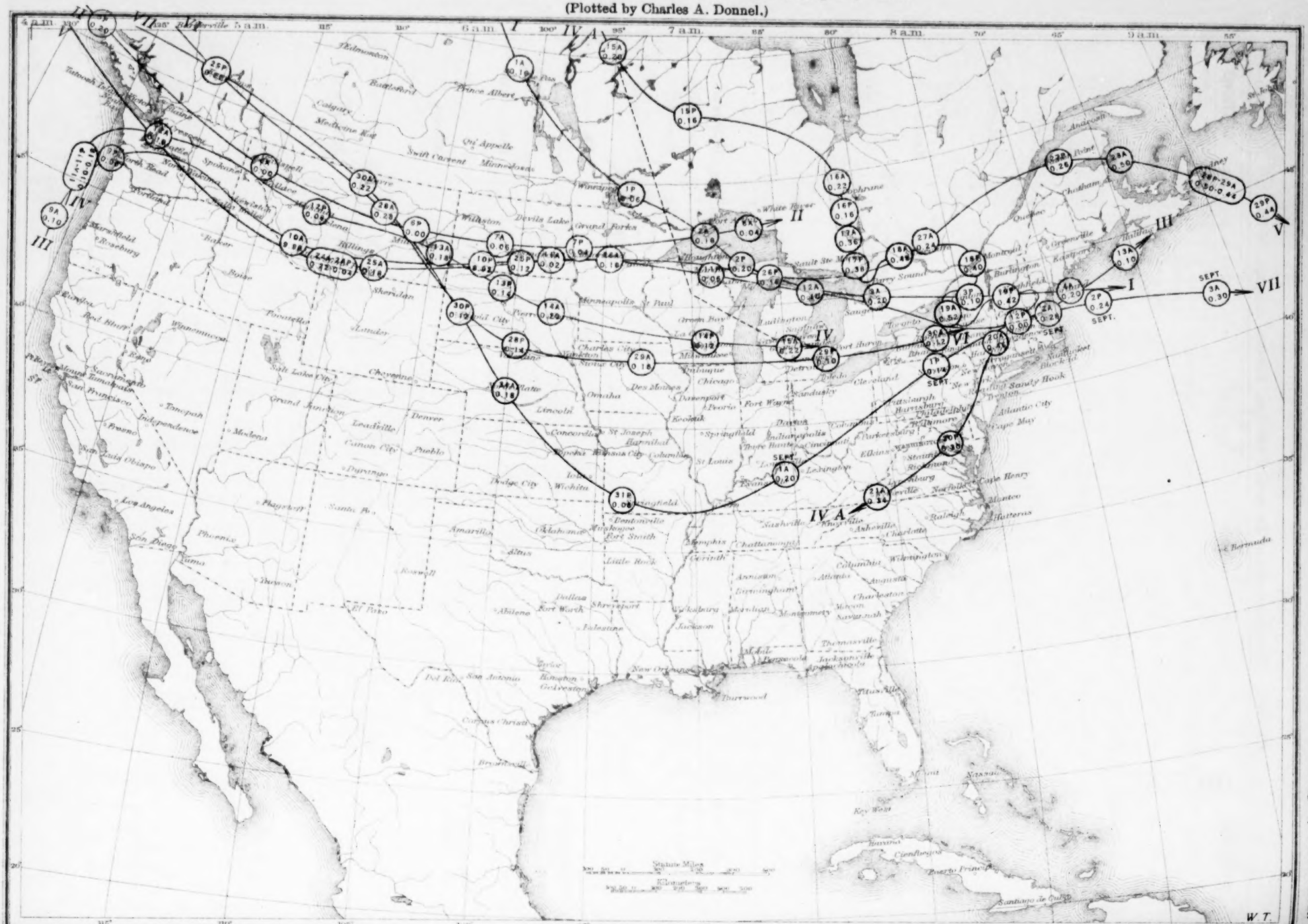


Chart III. Tracks of Centers of Low Areas, August, 1918.

Chart III. Tracks of Centers of Low Areas, August, 1918.

(Plotted by Charles A. Donnel.)

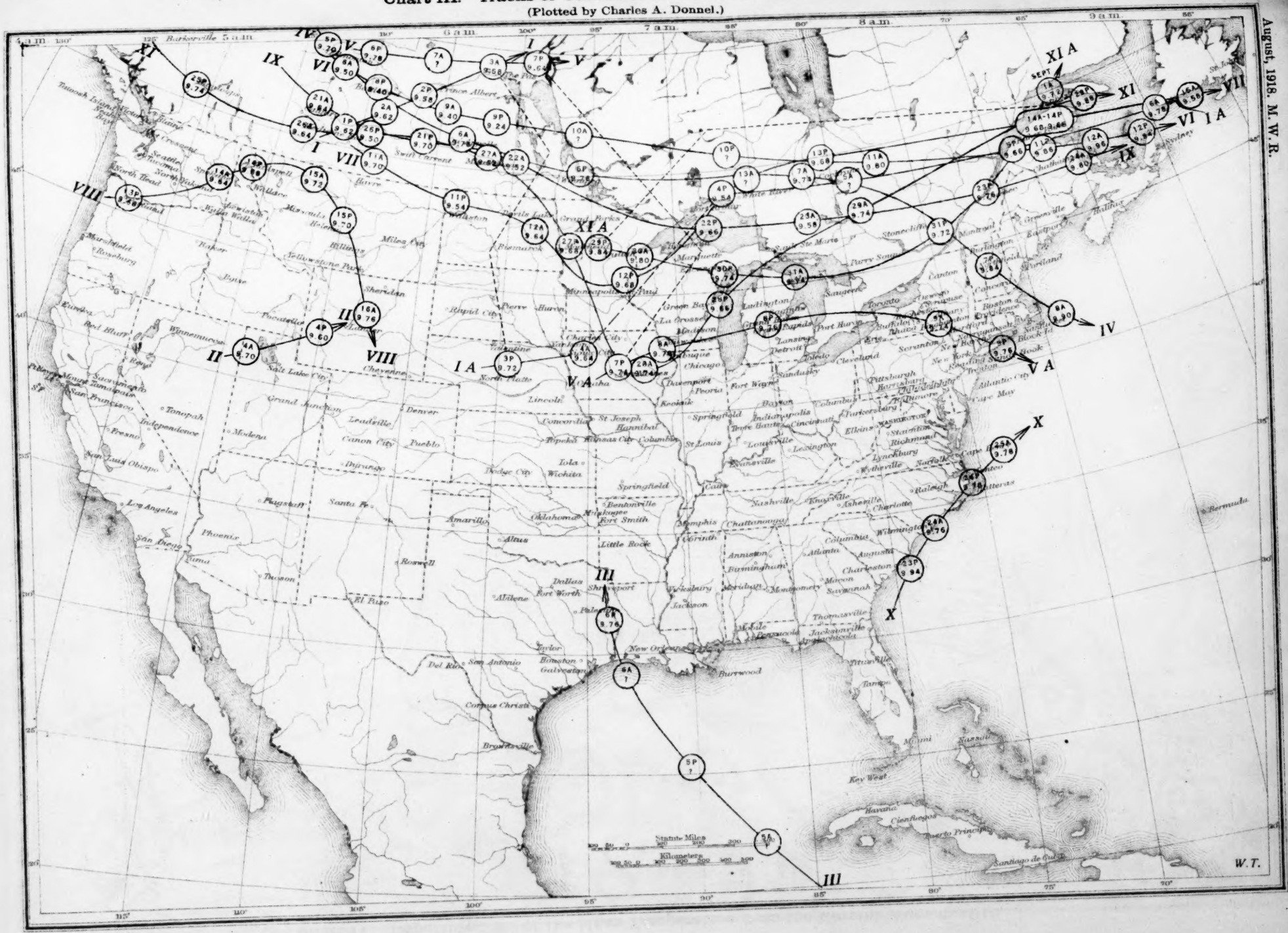


Chart IV. Departure (°F.) of the Mean Temperature from the Normal, August, 1918.

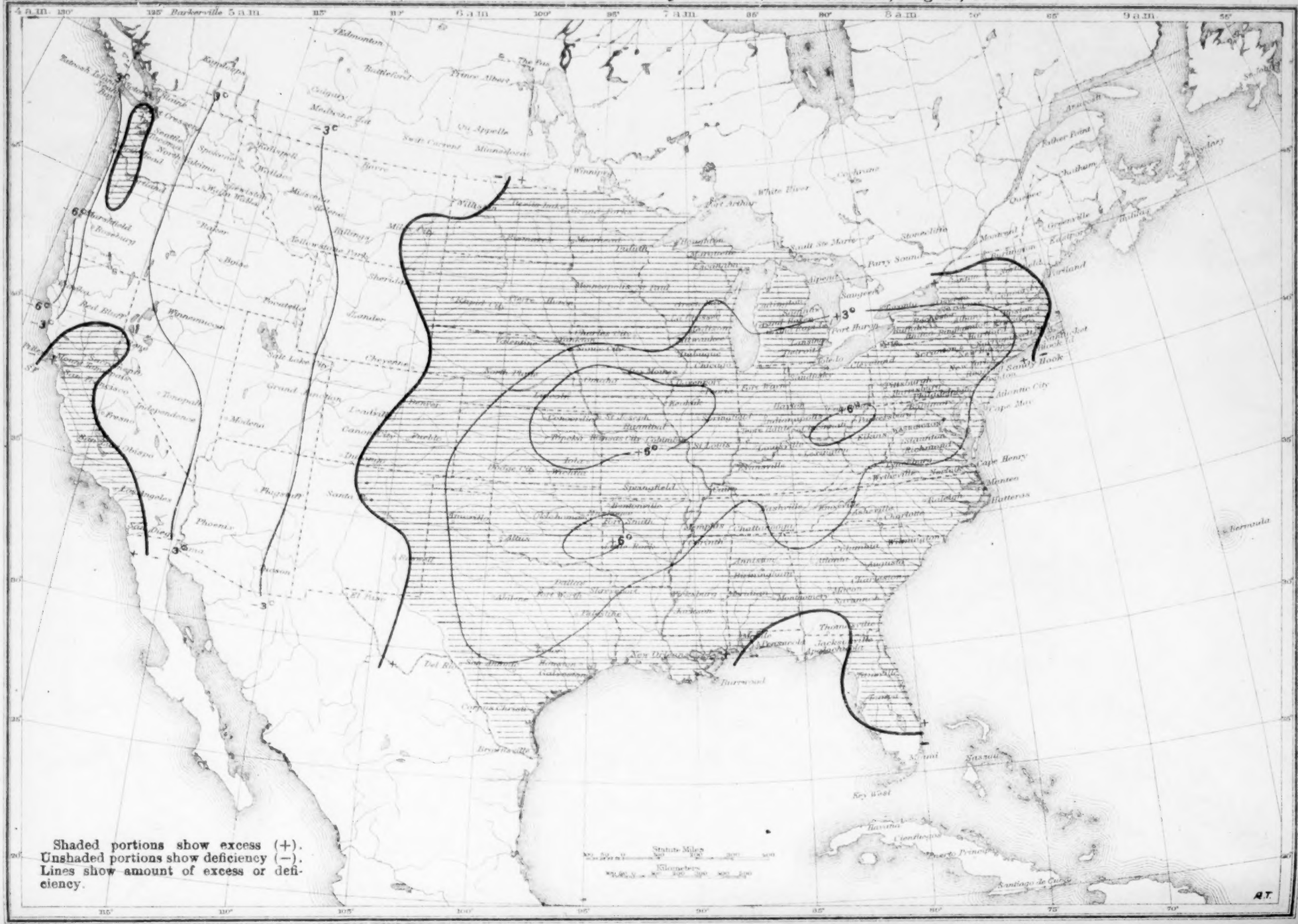


Chart V. Total Precipitation, Inches, August, 1918.

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, August, 1918.

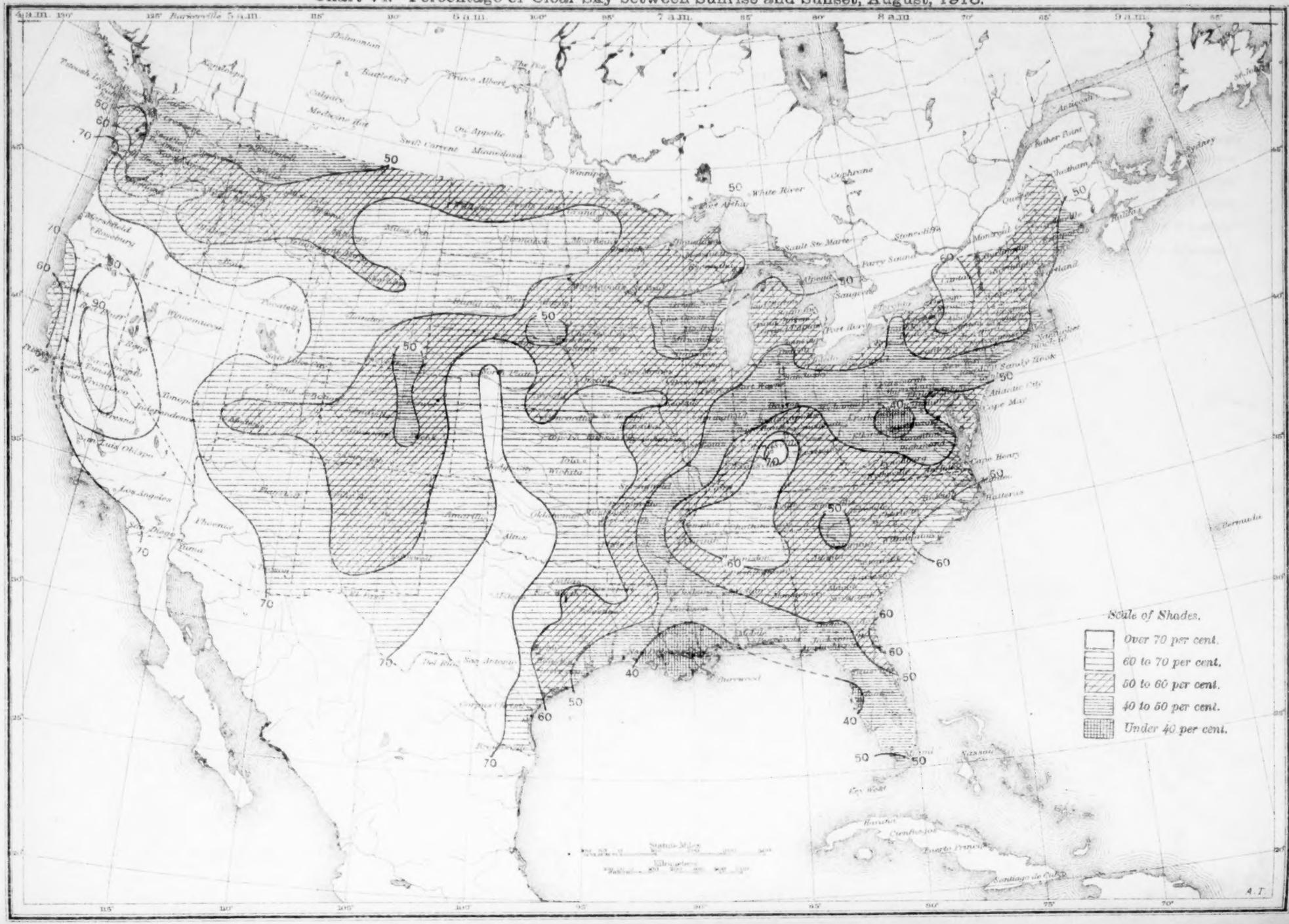
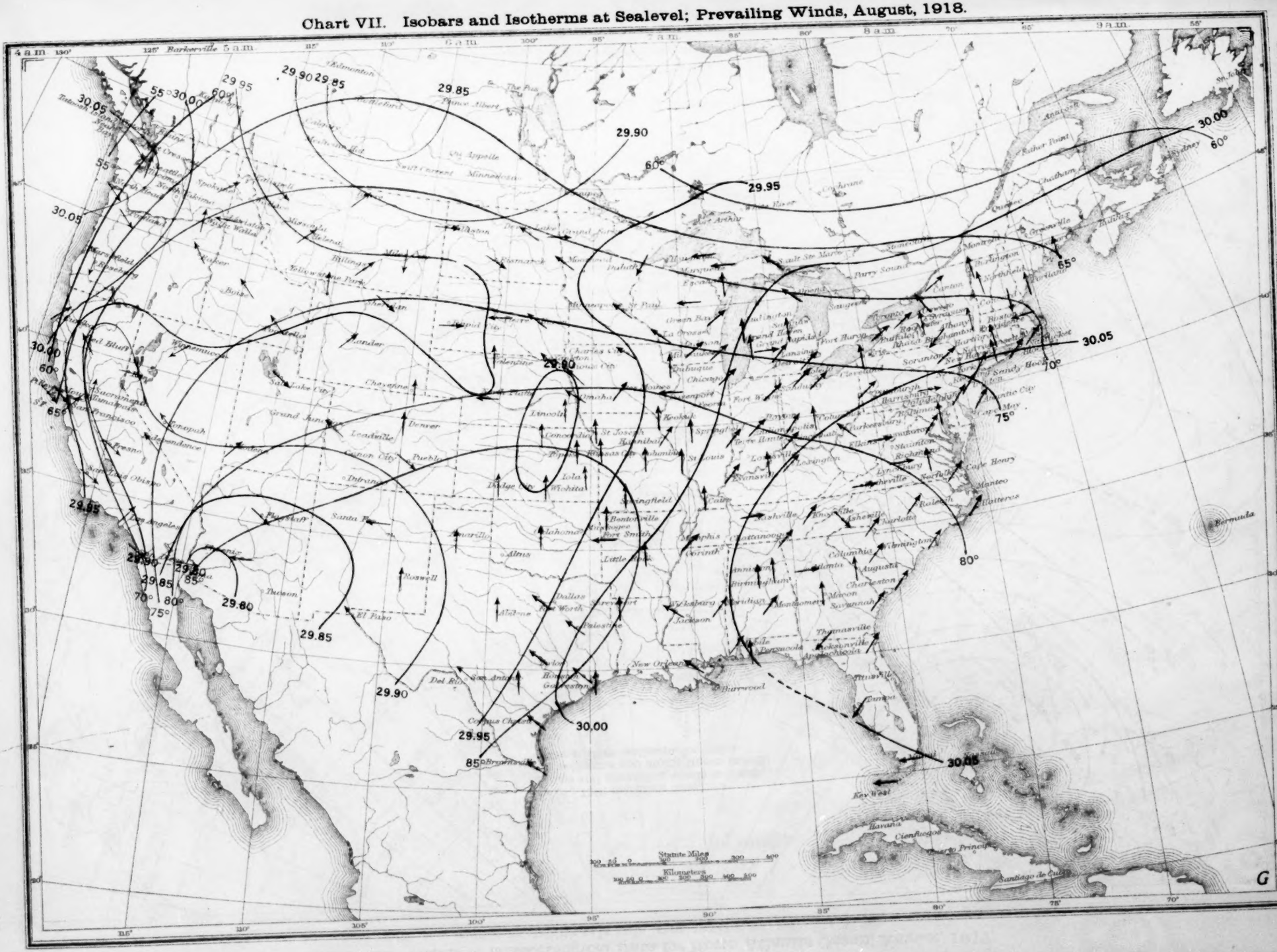


Chart VII. Isobars and Isotherms at Sealevel; Prevailing Winds, August, 1918.



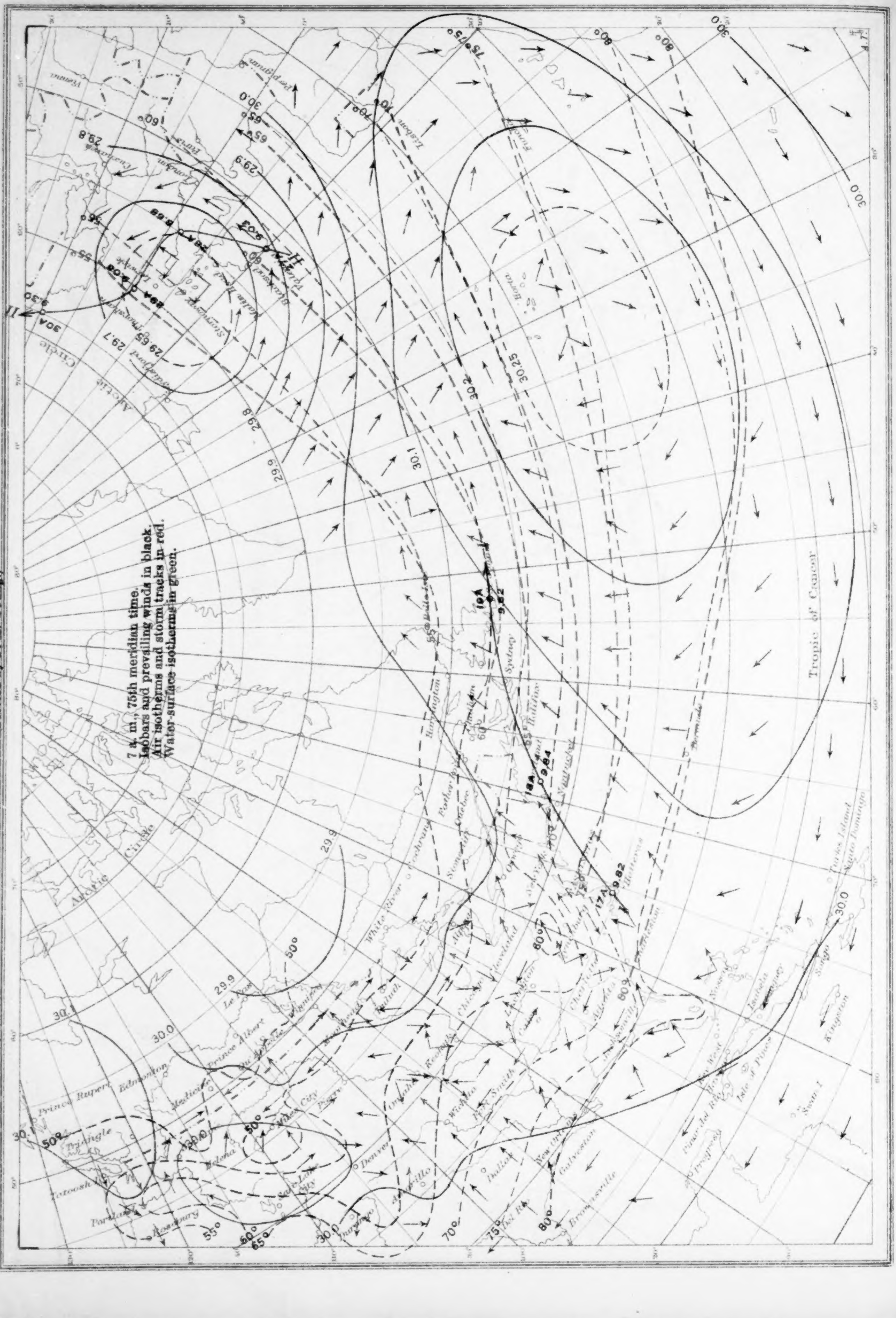


Chart IX. Means of Meteorological Data for North Atlantic Ocean, August, 1917.
(Plotted by F. A. Young.)

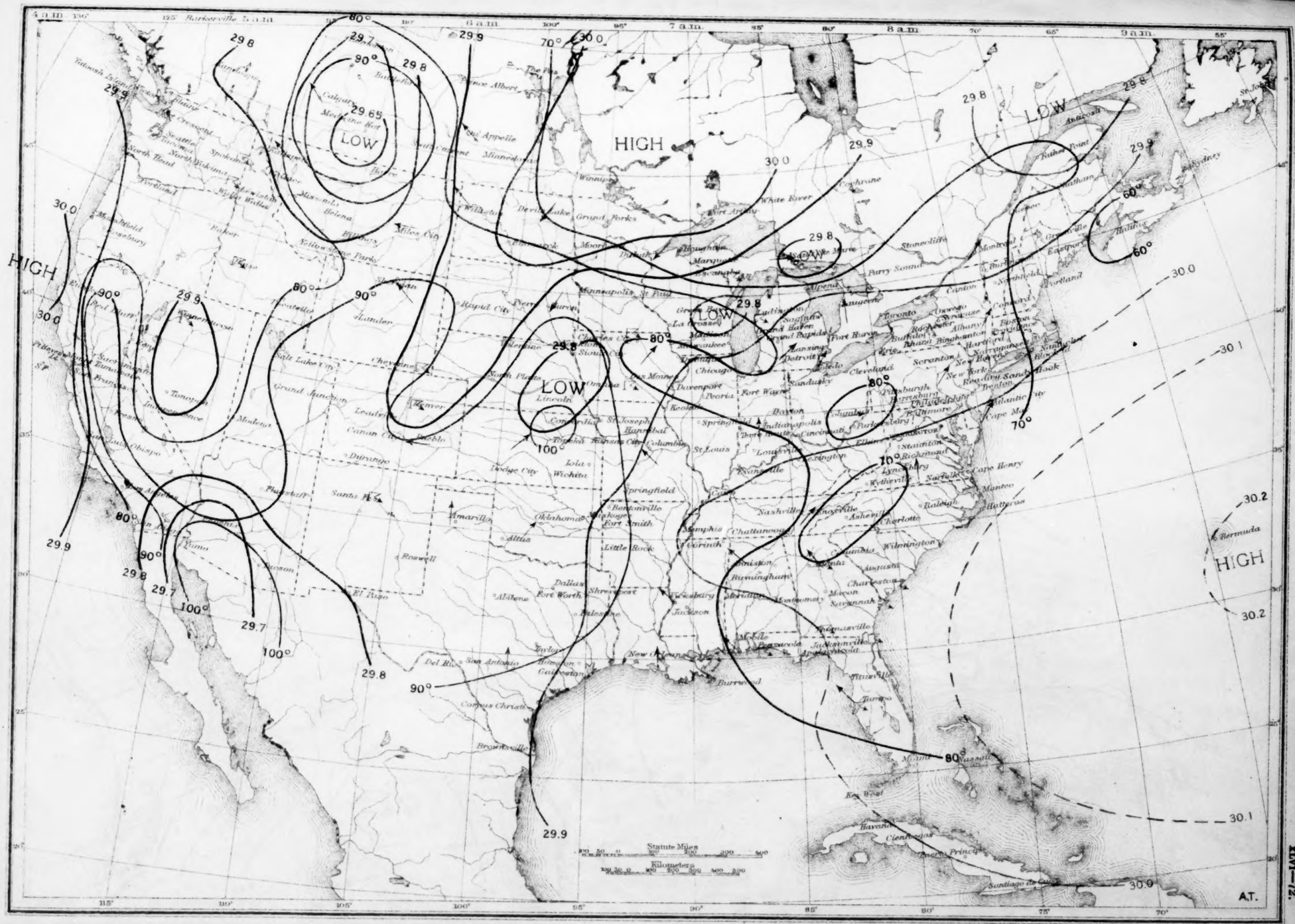


Fig. 1. Weather Map, 7 p. m., 75th meridian time, August 1, 1918.

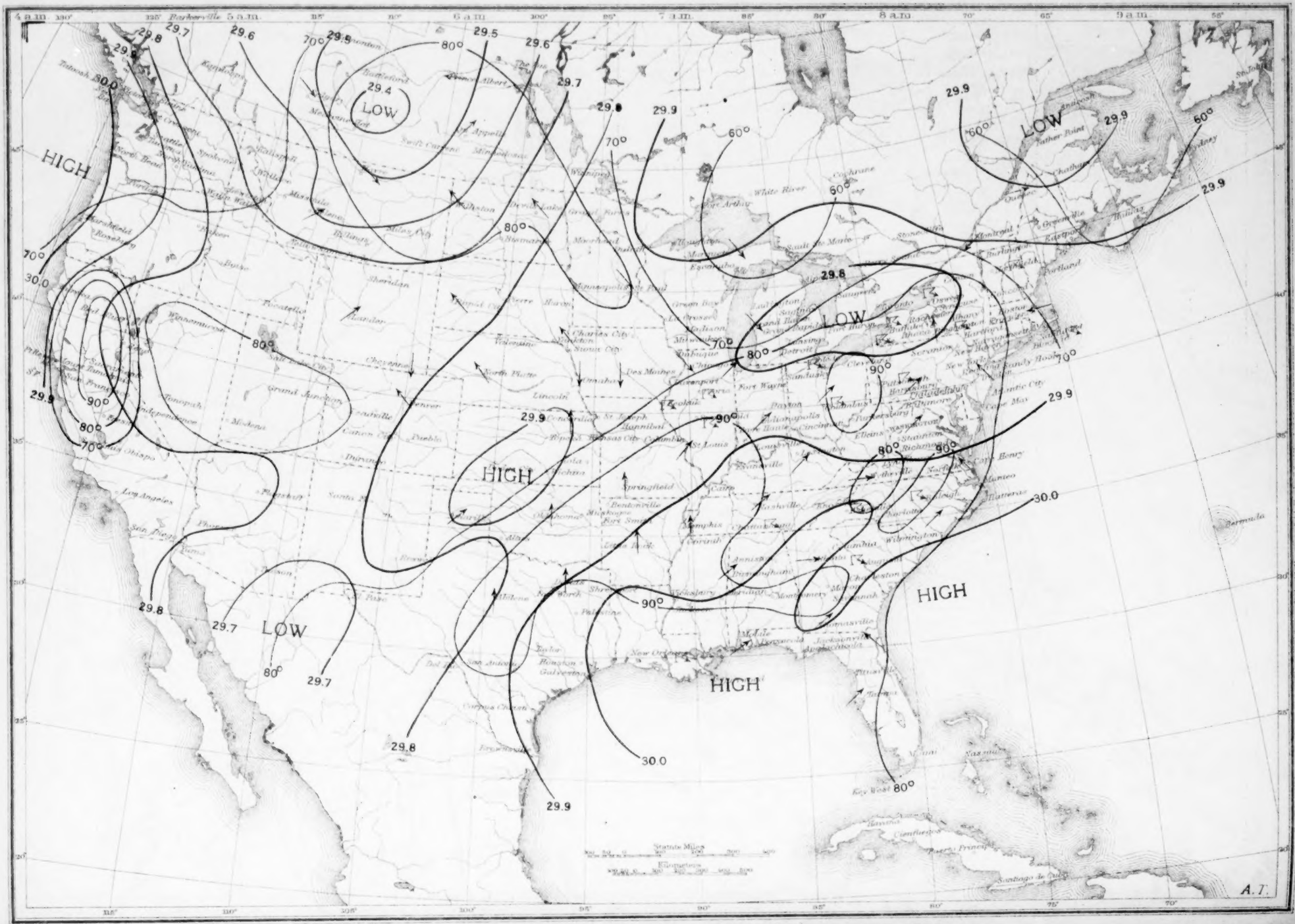


Fig. 2. Weather Map, 7 p. m., 75th meridian time, August 8, 1918.

Fig. 2. Weather Map, 7 p. m., 75th meridian time, August 8, 1918.

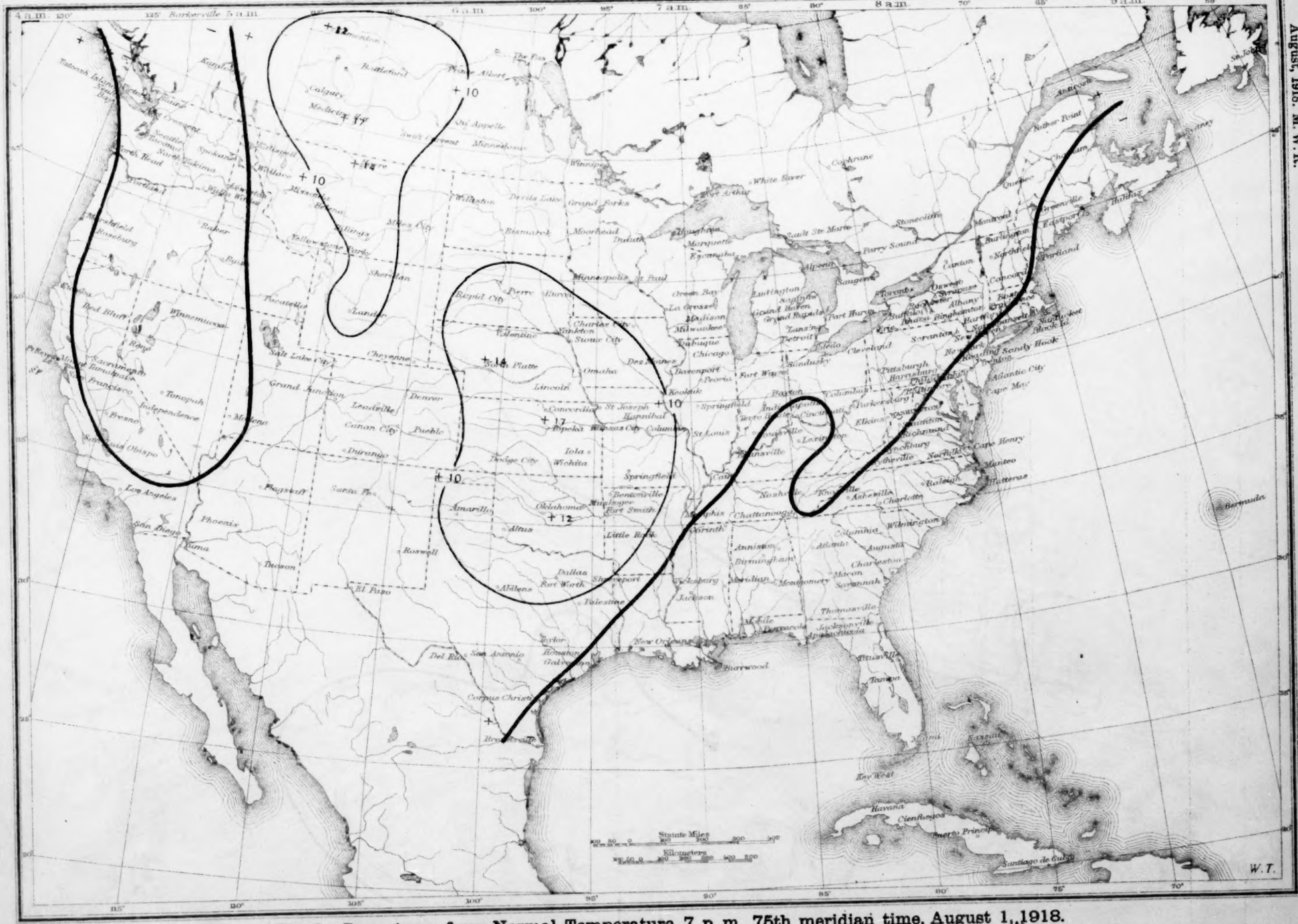


Fig. 3. Departures from Normal Temperature, 7 p. m., 75th meridian time, August 1,,1918.

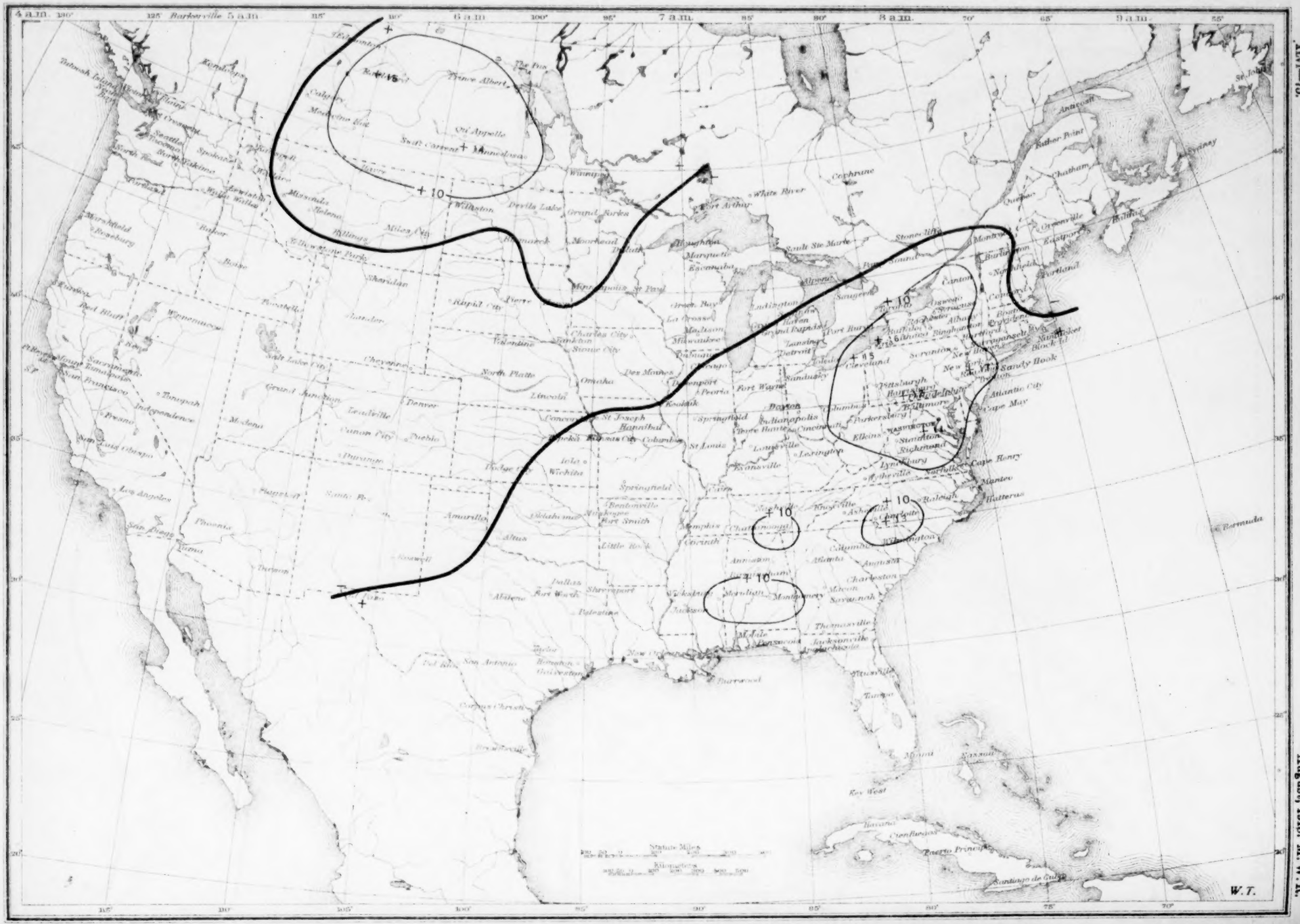


Fig. 4. Departures from Normal Temperature, 7 p. m., 75th meridian time, August 8, 1918.